PHYSICOCHEMICAL PARAMETERS AND SENSORY PROPERTIES OF LAMB BURGER MANUFACTURED WITH DIFFERENT CONCENTRATIONS OF OREGANO EXTRACT

Rafaella de P. Paseto Fernandes[1*], Marco A. Trindade[1], Fernando G. Tonin[1], Silvana M. P. Pugine[1], Merícia H. Hirano[1], José M. Lorenzo Rodríguez[2] and Mariza P. de Melo[1]

[1]College of Animal Science and Food Engineering, University of São Paulo, Avda. Duque de Caxias Norte, 225, CEP 13.635-900, Pirassununga, São Paulo, Brazil

[2]Centro Tecnológico de la Carne de Galicia, Avda. de Galicia, n. 4, 32900, Parque Tecnológico de Galicia, San Cibrao das Viñas, Ourense, Spain

*rafaellapaseto@usp.br

Abstract – The aim of this study was to assess the influence of the addition of natural antioxidant (*Origanum vulgare* extract) in different concentrations on physicochemical characteristics and sensory properties of lamb burgers. A total of five batches of lamb burgers were prepared: without antioxidants (blank), with sodium erythorbate (control) and with three different amounts of natural extract [calculated according to three different analytical techniques: Folin-Ciocalteau, ferric reducing/antioxidant power (FRAP) and DPPH˙ (1,1-diphenyl-2-picrylhydrazyl) radical inhibition. Physicochemical parameters (pH, texture profile analysis (TPA) traits, cooking loss, diameter reduction and instrumental color) and sensory characteristics (9-point hedonic scale) were assessed. Instrumental color, TPA traits, cooking loss and diameter reduction did not show significant (*P>0.05*) differences among batches. However, lamb burgers with higher content of oregano extract presented (*P<0.05*) lower pH values in comparison to sodium erytorbate. Regarding sensory attributes, all burgers with oregano extract were not different (*P>0.05*), but those with lower and higher concentrations of extract obtained higher scores for flavor and overall acceptability (*p<0.01*) when compared to blank and control treatments. In conclusion, the addition of oregano extract in all concentrations tested did not compromise most of the physicochemical parameters evaluated but led to better sensory acceptance of lamb burger.

Key Words – DPPH˙, Folin-Ciocalteau, FRAP, *Origanum vulgare*, sodium erythorbate.

I. INTRODUCTION

Nowadays, the consumption for healthier products is increasing in Brazil and represents a major trend worldwide. One reason for these consumers behavior is that numerous studies revealed a direct relationship between the intake of foods containing synthetic antioxidants commonly used in the food industry, and the increased development of many degenerative and inflammatory diseases. In this regard, the vegetable sources are rich in antioxidant compounds including a variety of herbs and spices that can be used in foods, promoting the inhibition of free radicals. For all this, the use of natural antioxidants can also reduce the development of lipid oxidation that is a critical factor for the maintenance of quality of the food [1, 2, 3]. Due to this, many studies are being conducted with the use of natural antioxidants in meat products, being the oregano, a plant of the family *Lamiaceae* most studied due to the high antioxidant potential [4].

Thus, the present study aimed to analyze different concentrations of natural antioxidant extract, obtained from calculations based on the equivalence of sodium erythorbate according to the antioxidant capacity of these, as well as to verify the behavior and efficiency in relation to physicochemical characteristics and sensory properties of lamb burgers.

II. MATERIALS AND METHODS

A. Preparation of natural antioxidant

The extract of *Origanum vulgare* was obtained in triplicate using a chemical solvent mixture (70% acetone/28% ultrapure water/2% acetic acid) in ratio of the 1:50 (g/mL) [5], being subjected to grinding, agitation, centrifugation, filtration, concentration, lyofilization and ressuspension in ultrapure water.

B. *Evaluation of antioxidant capacity*

The samples, as well as the sodium erythorbate, were evaluated for antioxidant capacity by Folin-Ciocalteau, FRAP (Ferric ion Reducing Antioxidant Power) and DPPH$^{\cdot}$ (2,2-diphenyl-1 picrylhydrazyl) [6].

C. *Processing of the burgers*

Burgers formulation consisted of meat (84%), and fat trimmings (14%) of lamb, 2% salt and antioxidant. The meat and fat were thawed at 4 ºC for 12 hours and minced separately using disc of the 4 mm. A total of five batches were prepared: without antioxidants (blank), with sodium erythorbate (control) and three different amounts of natural extract. Burgers manufacture was done three different times and to samples with natural extract, the quantities were calculated regarding equivalent antioxidant power as 500 ppm sodium erythorbate using results obtained for colorimetric methods (Table 1). The burgers (95-100 grams) were formed using a manual molder (112 mm diameter x 2 cm height) and individually separated with polyethylene films. Burgers were frozen in ultra freezer, packed in air-permeable polypropylene bags, being immediately stored at -18 ºC and analyzed after 4 days. A total of 30 burgers were analyzed (5 batches x 3 different times of manufacture x 2 samples of each batch).

Table 1 Results to Folin-Ciocalteau (A), DPPH$^{\cdot}$ (B) and FRAP (C) for oregano extract, equivalences and volumes (mean±standard deviation)

	Reducing power*	Equivalence[4]	Volume[5]
A[1]	74.01±7.33	4139.82±404.14	13.32±1.30
B[2]	9.06±0.10	5529.34±63.21	17.79±0.20
C[3]	472.32±15.96	7463.08±256.79	24.01±0.83

[1*]Results expressed in mg of gallic acid/g; [2*]Results expressed in % equivalence Trolox/g of dry sample; [3*]Results expressed in µmol de Trolox/g; [4]Results expressed in ppm; [5]Results expressed in mL/kg of meat product

D. *pH*

The pH was measured in each two samples per batch in triplicate using a pH meter (HANNA, HI 99163) with combined electrode to perforation.

E. *Instrumental color measurement*

Burgers were subjected to objective color analysis through evaluation system L*, a* and b* parameters of system CIELab, using a portable colorimeter (Model XE MiniScan, Mark HunterLab), with illuminant D65, observation angle of 10º and open cell of 30 mm. Six readings at different points of the surface of each burger were taken after 10 minutes of samples exposition to atmosphere.

F. *Water loss from cooking, diameter reduction and Texture Profile Analysis*

The water loss from cooking (WLC) and diameter reduction (DR) were determined using the following equations: WLC (%) = [(uncooked weight − cooked weight) / uncooked weight)] × 100 and DR (%) = [(uncooked diameter − cooked diameter)/uncooked weight)] × 100. Burgers were cooked at 180 °C for 8 minutes using an electric griddle, turned over every 2 minutes interval, until the internal temperature reached 72 °C. To the Texture Profile Analysis (TPA), each burger was cut in six pieces measuring 2×2×1 cm, and the samples were subjected to axial compression tests twice to 50% of their original height with a flat cylindrical probe (20 mm) and crosshead speed of 2 mm/s. The following parameters were determined: hardness (kg), springiness (mm), cohesiveness, gumminess (kg) and chewiness (kg x mm).

G. *Sensory analysis*

For the sensory evaluation sixty consumers from FZEA/USP, located in Pirassununga-São Paulo, were recruited. The burgers were submitted to the affective acceptance test using a 9-point hedonic scale (1 - "extremely dislike" to 9 - "extremely like") according to Meilgaard *et al.* [7]. The samples were cooked according described to

WLC, DR and TPA, being the samples cut in six pieces at diagonal and served individually, inside disposable plastic cups, coded by three-digit numbers. A randomized complete block design was used, and the panelists assessed the attributes aroma, texture, juiciness, flavor and overall acceptability.

H. Statistical analysis

The results were analyzed using analysis of variance (ANOVA), using the IBM SPSS Statistics 19.0 (IBM Corporation, Somers, NY, USA). A Duncan´s test was performed to compare the mean values at a significance level of $P<0.05$.

III. RESULTS AND DISCUSSION

The influence of natural antioxidant on physicochemical properties of lamb burgers is shown in Table 2. Statistical analysis displayed that pH values was significantly ($P<0.05$) affected by the addition of oregano extract, since the lamb burgers manufactured with the highest extract concentration presented the lowest pH values in comparison to sodium erythorbate. These findings are in agreement with those reported by Lorenzo *et al.* [8] who noticed lower pH values in burgers containing tea, seaweed and grape extracts compared to control group. This behavior can be explained by the presence of active compounds in the extracts which can promote a decrease of pH value.

On the other hand, color parameters did not present significant ($P<0.05$) differences among treatments. This outcome is in line with the results observed by Colindres *et al.* [9], who did not found color alterations in burgers containing oregano, grape and rosemary extracts. However, Lorenzo *et al.* [10] reported that the addition of tea and seaweed extracts led to patties with significantly ($P<0.001$) lower a* values, whereas chestnuts and grape extracts caused a significant ($P<0.001$) increase of b* values.

The addition of the oregano extract in lamb burgers did not show significant ($P>0.05$) differences for TPA traits, WLC and DR. These findings are in agreement with those reported by Hayes *et al*. [11] who did not notice significant ($P>0.05$) differences in DR (values ranged from 30.30 to 36.60%) in beef burgers manufactured with different antioxidants.

With respect to sensory characteristics, aroma and texture did not show significant ($P>0.05$) differences among treatments (Table 3). However, the incorporation of oregano extract in lamb burgers improved the flavor and overall acceptability ($P<0.01$), being that N1 and N3

Table 2 Effect of extract level on physicochemical properties of lamb burgers (medium values±standard deviation)

	Blank	Sodium erythorbate	N1[1]	N2[2]	N3[3]	S[4]
pH	5.99±0.05[a]	5.99±0.04[a]	5.92±0.04[ab]	5.91±0.02[ab]	5.89±0.03[b]	*
Color Parameters						
L*	46.41±3.80	46.70±3.40	46.77±3.31	47.61±3.34	47.25±3.22	n.s.
a*	9.17±0.56	8.30±0.95	9.21±0.61	8.64±0.78	7.97±0.29	n.s.
b*	16.51±0.84	14.98±0.67	16.27±0.78	15.95±0.61	15.19±1.18	n.s.
TPA traits						
Hardness (kg)	4.67±0.63	4,29±0.54	4.42±0.55	3.96±0.29	4.03±0.40	n.s.
Springiness (mm)	0.83±0.01	0.83±0.01	0.83±0.01	0.81±0.01	0.81±0.02	n.s.
Cohesiveness	0.67±0.02	0.68±0.02	0.68±0.02	0.66±0.02	0.66±0.02	n.s.
Gumminess (kg)	3.13±0.33	2.92±0.29	3.00±0.31	2.60±0.10	2.67±0.21	n.s.
Chewiness (kg x mm)	2.59±0.26	2.39±0.20	2.47±0.23	2.12±0.08	2.16±0.13	n.s.
WLC (%)	25.40±9.31	22.05±7.29	22.57±7.99	24.22±8.07	25.95±7.53	n.s.
DR (%)	23.14±3.01	23.55±4.09	23.18±4.35	25.66±2.13	26.54±4.76	n.s.

[1,2,3]:Level of oregano extract based on equivalence by the Folin-Ciocalteau, DPPH˙ and FRAP methods, respectively; [4]:Significance: *** ($P<0.001$), ** ($P<0.01$), * ($P<0.05$), n.s. = $P>0.05$; [a,b]: Mean values in the same row not followed by a common letter differ significantly ($P<0.05$); TPA: Texture Profile Analysis; WLC: water loss from cooking; DR: diameter reduction

Table 3 Effect of extract level on sensory characteristics of lamb burgers (medium values±standard deviation)

	Blank	Sodium erythorbate	N1[1]	N2[2]	N3[3]	S[4]
Aroma	6.00±1.41[a]	6.40±1.65[a]	6.62±1.40[a]	6.48±1.31[a]	6.52±1.50[a]	n.s
Texture	6.17±1.73[a]	6.03±1.78[a]	6.45±1.48[a]	6.52±1.81[a]	6.75±1.63[a]	n.s
Juiceness	6.52±1.70[b]	6.80 1.46[ab]	7.23±1.34[a]	7.08±1.41[a]	7.23±1.38[a]	*
Flavor	5.93±2.02[c]	6.27 1.71[bc]	7.17±1.52[a]	6.73±1.61[ab]	6.93±1.74[a]	**
Overall acceptability	6.05±1.71[c]	6.23± 1.50[bc]	7.00±1.23[a]	6.67±1.41[ab]	6.92±1.53[a]	**

[1,2,3]:Level of oregano extract based on equivalence by the Folin-Ciocalteau, DPPH˙ and FRAP methods, respectively; [4]:Significance: *** (P<0.001), ** (P<0.01), * (P<0.05), n.s. = P≥0.05; [a,b,c]: Mean values in the same row not followed by a common letter differ significantly (P<0.05).

presented higher scores when compared to treatment containing sodium erythorbate, but not differing from N2. Contrary to the results obtained in the present study, Lee *et al.* [12] did not notice significant (P>0.05) differences among burgers (control, BHA and rosemary extract).

IV. CONCLUSION

From the results obtained, it can be concluded that all evaluated concentrations of the extract of oregano could be used by the meat industry because it is a source of natural antioxidants that contribute to improve the sensory acceptability of lamb burgers, without compromising most of its technological parameters.

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REFERENCES

1. Gobert, M., Gruffat, D., Habeanu, M., Parafita, E., Bauchart, D. & Durand, D. (2010). Plant extracts combined with vitamin E in PUFA-rich diets of cull cows protect processed beef against lipid oxidation. Meat Science 85:676-683.
2. Ahn, J. H., Kim, Y. P. & Kim, H. S. (2012). Effect of natural antioxidants on the lipid oxidation of microencapsulated seed oil. Food Control 23:528-534.
3. Karre, L., Lopez, K. & Getty, K. J. K. (2013). Natural antioxidants in meat and poultry products. Meat Science 94:220-227.
4. Velasco, V. & Williams, P. (2011). Improving meat quality through natural antioxidants. Chilean Journal of Agricultural Research 71:313-322.
5. Michiels, J. A., Kevers, C., Pincemail, J., Defraigne, J. O. & Dommes, J. (2012). Extraction conditions can greatly influence antioxidant capacity assays in plant food matrices. Food Chemistry 130:986-993.
6. Dudonné, S., Vitrac, W., Coutière, P., Woillez, M. & Mérillon, J. M. (2009). Comparative study of antioxidant properties and total phenolic content of 30 plant extracts of industrial interest using DPPH, ABTS, FRAP, SOD and ORAC assays. Journal of Agricultural and Food Chemistry 57:1768-1774.
7. Meilgaard, M. C., Civille, G. V. & Carr, B. T. (1991). Sensory Evaluation Techniques. Boca Raton: CRC Press.
8. Lorenzo, J. M., González-Rodríguez, R. M., Sánchez, M., Amado, I. R. & Franco, D. (2013). Effects of natural (grape seed and chestnut extract) and synthetic antioxidants (buthylatedhydroxytoluene, BHT) on the physical, chemical, microbiological and sensory characteristics of dry cured sausage "chorizo". Food Research International 54:611-620.
9. Colindres, P. & Brewer, M. S. (2011). Oxidative stability of cooked, frozen, reheated beef patties: effect of antioxidants. Journal of the Science of Food and Agriculture 91:963-968.
10. Lorenzo, J. M., Sineiro, J., Amado, I. R. & Franco, D. (2014). Influence of natural extracts on the shelf life of modified atmosphere-packaged pork patties. Meat Science 96:526-534.
11. Hayes, J. E., Stepanyana, V., Allena, P., O'Grady, M. N. & Kerry, J. P. (2010). Effect of lutein, sesamol, ellagic acid and olive leaf extract on the quality and shelf-life stability of packaged raw minced beef patties. Meat Science 84:613-620.
12. Lee, J. W., Park, K. S., Kim, J. G., Oh, S. H., Lee, Y. S., Kim, J. H. & Byun, M. W. (2005). Combined effect of gamma irradiation and rosemary extract on the shelf life of a ready-to-eat hamburger steak. Radiation Physics and Chemistry 72:49-56.