EFFECTS OF GARLIC POWDER AND SALT AS INGREDIENTS IN RABBIT MEAT BURGERS

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ABSTRACT

The effects of garlic powder and salt were assessed on physical–chemical traits of rabbit burgers. Four type of burgers were formulated (only meat - control; 0.25% of garlic powder; 1% of salt; 0.25% of garlic powder and 1% of salt). Burgers (a total of 180 samples) were analysed both as raw and cooked products for the determination of pH, colour indexes, water holding capacity, lipid and protein oxidation, antioxidant capacity, tocopherols and tocotrienols content and fatty acids profile. Garlic powder partially modified the chemical characteristics of the burgers (mostly colours indexes and in particular b* index of raw samples, $P<0.05$) and partially increased the antioxidant capacity of the samples. Addition of salt increased the lipid and protein oxidations showing a doubling of TBARS values of raw samples (control 0.08 mg MDA/100 g to 0.25 mg MDA/100 g of burgers with 1% of salt, $P<0.001$) and a six-fold increase of carbonyls (from 5.71 to 29.47 nmol of carbonyl/mg of protein, respectively for the control and the formulation with 1% of salt, $P<0.001$). The burgers with both garlic powder and salt showed mixed results. Mixing garlic powder and salt could be a potential practical application although garlic powder partially increased the antioxidant capacity of the burgers and did not counteract completely the prooxidant properties of the salt.

Key words: Meat quality, Natural antioxidant, Garlic, Burger, Antioxidant capacity, Fatty acids profile.

INTRODUCTION

Worldwide rabbit meat is commonly sold as whole carcass or as cut□up parts and its consumption are nowadays decreasing (Petracci *et al.*, 2018a). A possible solution could be to formulate rabbit meat products or at least introduce rabbit meat as an ingredient in processed food products (Petracci *et al.*, 2018b). Between meat products burgers are the more sold worldwide. Success of burgers is related to the easiness to be cook, to the large variability of possible seasoning. Burgers could be also sold as raw or cooked products (ready□to□cook and ready□to□eat) and that represent an enormous potential for food industries.
Natural antioxidants were studied as ingredients in several other meat products and represent one of the main response of food industries to the growing attention showed by consumers to avoid the use of synthetic antioxidant molecules (Falowo *et al.*, 2014). The main aim of our research was to test different activities of ingredients in rabbit meat product, in particular, we tested garlic powder and salt to determine their antioxidant/oxidant activities and effects on burgers characteristics. As our goal was to improve knowledges in rabbit meat products manufacturing where we also tested in combination the two ingredients in order to lead to more reliable product.

MATERIALS AND METHODS

Experimental design and burgers manufacture

Frozen rabbit hind legs (-20°C, 1 month of frozen storage), were thawed for 18 hr at 4°C and then deboned. Twelve different meat batches were used during this research studies. Meat of each batch was finely ground with a meat mincer (DN30323, DiNa Professional, Catania, Italy) and batches were

randomly divided in four formulations (F, 3 batches per F), then meat samples were collected for proximate composition (moisture, ether extract, crude protein and ash; AOAC, 1995). One formulation was set as control (C, only meat) while the other three F consisted in meat added with garlic powder at 0.25% (w/w, G), meat added with salt at 1.00% (w/w, S) and meat added with garlic powder at 0.25% and salt at 1.00% (w/w, GS). Meat was mixed with the assigned ingredient and forty-five burgers of 100 g per F were formatted (five-teen per batch) in a burger hand forming machine (DN8097, DiNa Professional, Catania, Italy; diameter 100 mm), for a total of 180 burgers. Burgers were packaged in single Styrofoam trays, overwrapped with polyethylene film and stored raw at 4 ± 0.5 °C and analysed at day 0 and 7 (storage time, ST; T0 and T7).
Raw and cooked burgers were analysed at T0 and T7 for the determination of the pH, the colour indexes, the water holding capacity, lipid and protein oxidation, antioxidant capacity, tocopherols and tocotrienols content and fatty acids profile.

Meat quality, lipid oxidation, antioxidant capacity and fatty acids profile
The pH, colour, drip loss and cooking loss were evaluated following the methods reported by Mancini *et al.* (2015). Lipid and protein oxidation were evaluated spectrophotometrically measuring thiobarbituric acid reactive substances (TBAR; Leick *et al.*, 2010) with 532 nm as wavelength and carbonyls (Bradford, 1976; Lushchak *et al.*, 2005) using 370 nm. Results were expressed as mg MDA per 100 g sample and nmol of carbonyl/mg of protein, respectively for TBARS and carbonyls. Thiols content, were evaluated following (Lushchak *et al.*, 2005) and expressed as μmoL SH – group/g.
Antioxidant capacity was measured on meat ethanol extracts spectrophotometrically as reported by Mancini *et al.* (2015). ABTS and DPPH radical probes were employed as reported, respectively, by Re *et al.* (1999) and Blois (1958). The Fe(III)/Fe(II) redox couple was employed in FRAP method as reported by Descalzo *et al.* (2007). Standard concentration curves were plotted with Trolox; results were expressed as mmol of Trolox equivalent.
Tocopherols and tocotrienols content was evaluated as reported by Mattioli *et al.* (2019) using an HPLC system (Perkin Elmer series 200, equipped with an AS 950-10 autosampler, Tokyo, Japan) on a Synergy Hydro-RP column (4 μm, 4.6×100 mm; Phenomenex, Bologna, Italy). Identification was performed using a Fluorimetric detector (FD, model Jasco, FP-1525, Tokyo, Japan – excitation and emission wavelengths of 295 and 328 nm, respectively) and quantified based on external calibration curves prepared with increasing amounts of pure standards (Sigma-Aldrich, Steinheim, Germany) in ethanol.
Fatty acids were extracted and processed via transesterification with methanol (Folch *et al.*, 1957). FAMEs (fatty acid methyl esters) were analysed by gas chromatography and separated with an Agilent capillary column (30 m × 0.25 mm I.D., CPS Analitica, Italy) coated with a DB-Wax stationary phase (film thickness of 0.25 μm). Individual fatty acid methyl esters were identified with reference to the retention time of FAME mixture (Sigma–Aldrich, Germany) and calculated with the internal standard method (nonadecanoic acid, C19:0). Results were expressed as percentage of singular fatty acids on total FAME using the peak areas.

Statistical Analysis
A principal component analysis was conducted to determinate the relationship between pH, colour, fatty acids profile, lipid and protein oxidation, antioxidant capacity (ABTS, DPPH and FRAP), tocopherols, tocotrienols and thiols, respectively for raw and cooked samples; all the data were mean centred and scaled to a unit standard deviation before analysis. The R free software (R Core Team, 2015) was used for the statistical analysis.

RESULTS AND DISCUSSION

Results on the determinations performed on the raw samples are reported in the Figure 1A. Principal components 1 and 2 of the raw samples represent respectively the 29.53% and 17.43% of the variability and could be ascribed principally to the storage time (PC1) and to the present of the salt (PC2). The principal component analysis highlighted that at T0 no major effects could be ascribed nor garlic powder nor to salt as all the samples were gathered together on the left side of the biplot. After

seven days of storage (T7) the samples split into two clusters, one on the top right sector and one on the left bottom sector of the biplot. The T7 samples were divided into the two clusters in relation to the presence of the salt as the S and GS samples gathered together in contraposition with the C and G samples. Meat and more likely minced meat could be subject to a rapid deterioration of quality due to enzymatic and microbial degradation (Davies *et al.*, 1998; Hui *et al.*, 2001). The presence of the salt was correlated, after 7 days of storage, with an increasing lipid (TBARS) and protein (carbonyls) oxidations. Several research articles reported the prooxidant activity of salt and the increase in lipid peroxidation (Cui *et al.*, 2018; Mariutti and Bragagnolo, 2017). Garlic powder due to its natural content of antioxidant compounds (Chung, 2006; Lanzotti, 2006) slightly influenced the antioxidant capacity of the burgers, anyhow did not overtaken the oxidation of the product. As plotted into the biplot reported in the Figure 1 the presence of tocopherols and tocotrienols and the capacity to react with the radical probes of DPPH and ABTS were more ascribable to the samples with garlic powder at the T0 (G_0 and GS_0). PUFAs were highly represented in the products without salt and plotted in contraposition with the presence of SFAs and MUFAs.

Results on the determinations performed on the cooked samples are reported in the Figure 1B. As for the raw samples the PC1 and PC2 represented the effect of the storage time and the presence of the salt, respectively, with a percentage of variability of 36.12% and 17.12%. The interaction between the salt and the storage time induced a diversification between the samples S_7-GS_7 and the samples C_7 and G_7. As reported before the lipid oxidation and the formation of carbonyls were more closed the salt addition and garlic powder did not overtaken the worsening of the products. Tocopherols and antioxidant capacity were more hight at T0 than T7 and plotted more closed to the G and GS samples. The SFAs and MUFAs content increased with the storage time and with the presence of the salt, highlighting effects of the main factors on the chemical composition of the burgers. Physical parameters, such as the temperature, could denature antioxidant molecules, and induce a lack of action against lipid peroxidation and radical activity, anyhow, the capacity other food ingredients showed to prevent lipid peroxidation and maintain the antioxidant capacity after cooking (Ahn *et al.*, 2002; Mancini *et al.*, 2017).

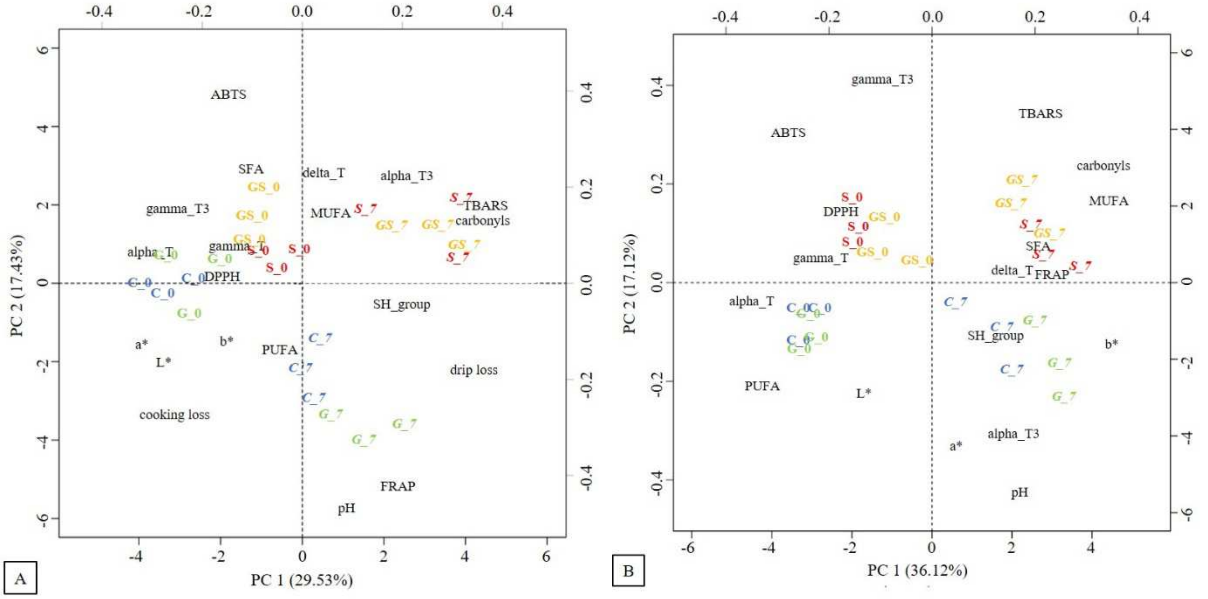

Figure 1: Biplot (loading and score plots) of the principal component analysis (PCA) of the raw samples (A) and of the cooked samples (B). (C, only meat; G, meat + 0.25% garlic powder; S, meat + 1.0% of salt; GS, meat + 0.25% garlic powder + 1.0% salt).

CONCLUSIONS

Garlic powder and salt could be to practical ingredients to formulate burgers with rabbit meat. Garlic powder affected mainly characteristics of raw burgers. Salt decreased cooking losses and increased lipid peroxidation in burgers. Mixing of garlic powder and salt showed results ranged between the two ingredients alone, highlighting a lack of garlic powder to counteract the prooxidant properties of the salt.

REFERENCES

Ahn J., Grün I., Fernando L. 2002. Antioxidant properties of natural plant extracts containing polyphenolic compounds in cooked ground beef. *J. Food Sci., 67(4), 1364–1369*.

AOAC. 1995. Official methods of analysis (15th ed.). *Washington DC, USA: Association of Official Analytical Chemists.*

Blois M.S. 1958. Antioxidant determinations by the use of a stable free radical. *Nature, 181, 1199–1200.*

Bradford M.M. 1976. A rapid and sensitive method for the quantitation of microgram quantities of protein utilizing the principle of protein-dye binding. *Anal. Biochem., 72(1–2), 248–254.*

Chung L.Y. 2006. The antioxidant properties of garlic compounds: allyl cysteine, alliin, allicin, and allyl disulfide. *J. Med. Food, 9(2), 205–213.*

Cui L., Fan J., Sun Y., Zhu Z., Yi J. 2018. The prooxidant activity of salts on the lipid oxidation of lecithin-stabilized oil-in-water emulsions. *Food Chem., 252, 28–32.*

Davies A.R., Board R.J., Board R.G. 1998. Microbiology of Meat and Poultry. *London: Springer Science & Business Media*.

Descalzo A.M., Rossetti L., Grigioni G., Irurueta M., Sancho A.M., Carrete J., Pensel N.A. 2007. Antioxidant status and odour profile in fresh beef from pasture or grain-fed cattle. *Meat Sci., 75(2), 309–317.*

Falowo A.B., Fayemi P.O., Muchenje V. 2014. Natural antioxidants against lipid–protein oxidative deterioration in meat and meat products: A review. *Food Res. Int., 64, 171–181.*

Folch J., Lees M., Sloane-Stanley G.H. 1957. A simple method for the isolation and purification of total lipides from animal tissues. *J. Biol. Chem., 226(1), 497–509.*

Hui Y.H., Nip W.K., Rogers R. 2001. Meat science and applications. *CRC Press.*

Lanzotti V. 2006. The analysis of onion and garlic. *J. Chromatogr. A, 1112(1–2), 3–22.*

Leick C.M., Puls C.L., Ellis M., Killefer J., Carr T.R., Scramlin S.M., England M.B., Gaines A.M., Wolter B.F., Carr S.N. McKeith F.K. 2010. Effect of distillers dried grains with solubles and ractopamine (Paylean) on quality and shelf-life of fresh pork and bacon. *J. Anim. Sci., 88(8), 2751–2766.*

Lushchak V.I., Bagnyukova T.V., Husak V.V., Luzhna L.I., Lushchak O.V., Storey K.B. 2005. Hyperoxia results in transient oxidative stress and an adaptive response by antioxidant enzymes in goldfish tissues. *Int. J. Biochem. Cell B., 37(8), 1670–1680.*

Mancini S., Preziuso G., Dal Bosco A., Roscini V., Parisi G., Paci G. 2017. Modifications of fatty acids profile, lipid peroxidation and antioxidant capacity in raw and cooked rabbit burgers added with ginger. *Meat Sci., 133, 151–158.*

Mancini S., Preziuso G., Dal Bosco A., Roscini V., Szendro Z., Fratini F., Paci G. 2015. Effect of turmeric powder (*Curcuma longa* L.) and ascorbic acid on physical characteristics and oxidative status of fresh and stored rabbit burgers. *Meat Sci., 110, 93–100.*

Mariutti L.R.B., Bragagnolo N. 2017. Influence of salt on lipid oxidation in meat and seafood products: A review. *Food Res. Int., 94, 90–100.*

Mattioli S., Dal Bosco A., Duarte J.M.M., D'Amato R., Castellini C., Beone G.M., Fontanella M.C., Beghelli D., Regni L., Businelli D., Trabalza-Marinucci M., Proietti P. 2019). Use of Selenium-enriched olive leaves in the feed of growing rabbits: Effect on oxidative status, mineral profile and Selenium speciation of *Longissimus dorsi* meat. *J. Trace Elem. Med. Bio., 51, 98–105.*

Petracci M., Soglia F., Baldi G., Balzani L., Mudalal S., Cavani C. (2018a). Technical note: Estimation of real rabbit meat consumption in Italy. *World Rabbit Sci., 26(1), 91.*

Petracci M., Soglia F., Leroy F. 2018b. Rabbit meat in need of a hat-trick: from tradition to innovation (and back). *Meat Sci., 146, 93–100.*

R Core Team. 2015. R: A language and environment for statistical computing. *R Foundation for Statistical Computing, Vienna, Austria*.

Re R., Pellegrini N., Proteggente A., Pannala A., Yang M., Rice-Evans C. 1999. Antioxidant activity applying an improved ABTS radical cation decolorization assay. *Free Radical Bio. Med., 26*(9–10), 1231–1237.