

Cinta Senese burgers with omega-3 fatty acids: effect of storage and type of enrichment on quality characteristics

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ADDITIONAL KEYWORDS

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SUMMARY

In Cinta Senese meat, polyunsaturated fatty acids (PUFA) only consists in the 10-11% of total fat. Moreover, the eicosapentaenoic and docosahexaenoic acids are not present in pork meat, but they are very abundant in fish products. In order to enhance Cinta Senese burgers healthiness, microencapsulated (M) and bulk fish oil (F) were added. The burgers were divided in three groups and underwent three different storage conditions: no storage (T0), chilled storage (T5) and frozen storage (T30). Fatty acid profile and lipid oxidation of enriched burgers were investigated after cooking. M burgers showed significantly higher amount of PUFA at T0 and T5, in particular omega-3 PUFA resulted significantly higher in M samples at T0, T5 and T30. TBARs resulted to be influenced by addition, with significantly higher values in F burgers. In conclusion, fish oil microencapsulation technique appears to be effective to enrich meat in omega-3 fatty acids, protecting added PUFA from oxidation.

Effetto del tipo di conservazione e arricchimento in omega-3 sulla qualità di hamburger di Cinta Senese

SOMMARIO

Il contenuto di acidi grassi polinsaturi (PUFA) della carne suina di razza Cinta Senese è solo del 10-11% rispetto al contenuto di grasso totale. Inoltre, gli acidi grassi eicosapentaenoico e docosahexaenoico non sono presenti nella carne suina, mentre sono molto abbondanti nei prodotti a base di pesce. Quindi, si è addizionato olio di pesce deodorizzato, o tal quale (F) o previa microincapsulazione (M), a hamburger di Cinta Senese, al fine di migliorarne la salubrità. Gli hamburger sono stati divisi in tre gruppi e sono stati sottoposti a tre diverse condizioni di conservazione: nessuna conservazione (T0), refrigerazione (T5) e congelazione (T30). Al termine del prestabilito periodo di conservazione, il prodotto è stato cotto e sono stati analizzati il profilo acidico e l'ossidazione lipidica. Gli hamburger del gruppo M hanno mostrato una quantità significativamente più alta di PUFA sia al T0 che al T5; in particolare i PUFA omega-3 sono risultati più alti negli hamburger M per tutte e tre le modalità di conservazione. La modalità di addizione dell'olio di pesce ha avuto effetti diversi sull'ossidazione lipidica; infatti, i valori più alti sono stati registrati per i prodotti del gruppo F. Per concludere, la tecnica di microincapsulazione dell'olio di pesce ha dimostrato di riuscire a proteggere al meglio dall'ossidazione i PUFA omega-3 addizionati, migliorando e garantendo così il contenuto di questi acidi grassi nel prodotto, anche dopo la cottura.

PAROLE CHIAVE AGGIUNTIVE

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INFORMATION

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INTRODUCTION

Among polyunsaturated fatty acids (PUFA) long-chained omega-3 α -linolenic acid (ALA C18:3 n-3), eicosapentaenoic acid (EPA C20:5 n-3) and docosahexaenoic acid (DHA C22:6 n-3), were demonstrated to be very beneficial to human health (Bang et al. 1971, p. 1143). So far, many studies have focused on adding these omega-3 PUFA to several food products in order to improve their nutritional characteristics (Valencia et al. 2008, p. 1046; Martinez et al. 2012, p. 200; Josquin et

al. p.81 2012; Keenan et al. 2015, p. 75) and, in a lesser part, to valorize some low demanded products, as Cinta Senese fresh meat. Cinta Senese is a local pig breed reared mainly in Tuscany; although its meat has a PDO label, consumers traditionally used to prefer Cinta Senese cured products as ham and salami. Moreover, Cinta Senese meat, as pork meat in general, is very rich in saturated fatty acids (SFA) being PUFA only the 10-11% (Pugliese et al. 2005, p. 459) of total fat. Among PUFA, omega-3 ones are poorly represented and generally

linked to particular feed and management strategies during the fattening period. However, EPA and DHA are never present in meat being characteristic of fish products. Therefore, the aim of this work was to fulfill consumers demand for high quality products and to valorize Cinta Senese fresh meat through the improvement of a largely demanded product: the burger. The enrichment was carried out using fish oil as source of omega-3 EPA and DHA and two different enrichment procedures were tested. Fatty acid profile and lipid oxidation were assessed in order to evaluate the influence of the enrichment procedure on burger quality traits.

MATERIALS AND METHODS

Multilayered microcapsules were elaborated following the methodology of Jiménez-Martín et al. (2015, p. 285). Cinta Senese fresh loins were minced and mixed with salt (2%), sulfites (0.05%) and mashed potato powder (2.4%); three experimental groups of burgers were made: control (C) group (n=15) with no further addition, microcapsules (M) group (n=15) and bulk fish (F) oil group (n=15). Five burgers of each group were immediately examined (T0), 5 of the remaining burgers were stored 5 days at +4°C (T5), while the last were stored during 30 days at -20 °C (T30). Physical-chemical and sensory attributes of enriched burgers were investigated after cooking at 165 °C during 6 minutes (American Meat Science Association, 1995).

Fatty acid methyl esters (FAMES) were prepared by basic transesterification of fat extracted from 5g of each burger (Folch et al. 1957, p. 497; A.O.A.C., 2000, reference 963.22) and they were analyzed by gas-chromatography (GC) using a Hewlett-Packard

HP-5890A gas chromatograph. Individual FAME peaks were identified by comparison of their retention times with those of standards (Sigma, St. Louis, MO, USA). Peak areas were measured and FAMES were expressed as area percentage of total area FAMES (%).

Lipid oxidation was detected measuring the thiobarbituric acid-reactive substances (TBARS) as described by Salih et al. (1987, p. 1483). Each burger was minced in a kitchen blender, and 2.5 g were homogenized for 2 min with 7.5 mL of 3.86% perchloric acid and 0.25 mL of butylatedhydroxytoluene (4.2%). This homogenate was filtered and centrifuged (4 min, 3500 rpm) and the supernatant (2 mL) was mixed with 2 mL of thiobarbituric acid 0.02 M. Parallel to sampling, a standard curve was prepared employing 1,1,3,3-tetraethoxypropane (TEP). The mixture was heated to 90 °C for 30 min, cooled and centrifuged again (2 min, 3500 rpm). Absorbance was measured at 532 nm on a spectrophotometer (Hitachi U-2000, Tokyo, Japan). TBARS were expressed as mg MDA kg⁻¹ sample.

The effect of cooking and type of enrichment were analyzed by ANOVA using IBM SPSS Statistics v.19 and, when significant differences were observed (P<0.05), they were evaluated by a Tukey's test.

RESULTS AND DISCUSSION

Table I shows fatty acids (FA) profile of C, M and F burgers over addition and over storage. The type of addition had significantly influenced the FA profile, especially at T0 and T5, where differences were found between control and modified burgers. Since the amount of PUFAs added was very limited, addition appeared to not affect PUFA group. This is in contrast with the observations of Josquin et al. (2012, p. 83) on modified sausages where the partial replacement of pork back-fat with microcapsules and fish oil had modified the fatty acid profile. At the level of single fatty acids, as expected, EPA and DHA were detected in added samples and among them, the M burgers showed the highest amount (P< 0.001). As a result of it, omega-3 content also resulted to be affected by addition; in fact, modified samples had a greater content (P<0.001) of omega-3 PUFA than control ones. These results suggest that, during cooking, microencapsulation had protected EPA and DHA from oxidation. Similar observations were reported also by Umesha et al. (2014, p. 654) on enriched biscuits; indeed, after baking, biscuits enriched with encapsulated oil showed a higher content of α -linolenic acid than of those with bulk oil.

Frozen storage (T30) resulted to have better preserved EPA, DHA (and consequently omega-3 total content) in F burgers respect of chilled storage. On the contrary in M burgers, frozen storage had determined a loss of DHA and omega-3 content if compared to chilled storage. This is probably due to the combination of the longer storage time (30 days) and a number of possible mechanism occurring during the spray-drying process, as well as the larger surface of microencapsulated fish oil in comparison with bulk oil microencapsulation process, which could have promoted omega-3 degradation processes, as suggested by Keenan et al.

Table I. Total fat and fatty acids. Different letters in the same row (a, b, c) indicate significant differences (P<0.05) over addition within the same storage conditions. Different letters in the same column (x, y) indicate significant differences (at least P<0.05) over storage (Grasso totale e acidi grassi. Lettere diverse nella stessa riga (a, b, c) indicano differenze significative (P<0.05) per il metodo di addizione a parità di tempo di conservazione. Lettere diverse nella stessa colonna (x, y) indicano differenze significative (minimo P<0.05) per la modalità di conservazione).

	Storage	Addition			
		C	M	F	P
EPA	T0	0.000 ^y	0.072 ^a	0.031 ^{by}	<0.001
	T5	0.009 ^{cy}	0.073 ^a	0.041 ^{by}	<0.001
	T30	0.021 ^{bx}	0.065 ^a	0.055 ^{ax}	<0.001
DHA	T0	0.000 ^c	0.099 ^{ay}	0.033 ^{by}	<0.001
	T5	0.000 ^c	0.149 ^{ax}	0.047 ^{by}	<0.05
	T30	0.000 ^b	0.095 ^{ay}	0.081 ^{ax}	<0.001
PUFA	T0	10.991 ^y	11.465 ^y	11.365	0.106
	T5	11.202 ^{by}	11.962 ^{ax}	11.415 ^{ab}	<0.05
	T30	11.450 ^x	11.645 ^x	11.783	0.558
N3	T0	0.579 ^c	0.781 ^{ay}	0.674 ^{by}	<0.001
	T5	0.602 ^b	0.864 ^{ax}	0.691 ^{by}	<0.001
	T30	0.640 ^b	0.779 ^{ay}	0.765 ^{ax}	<0.001

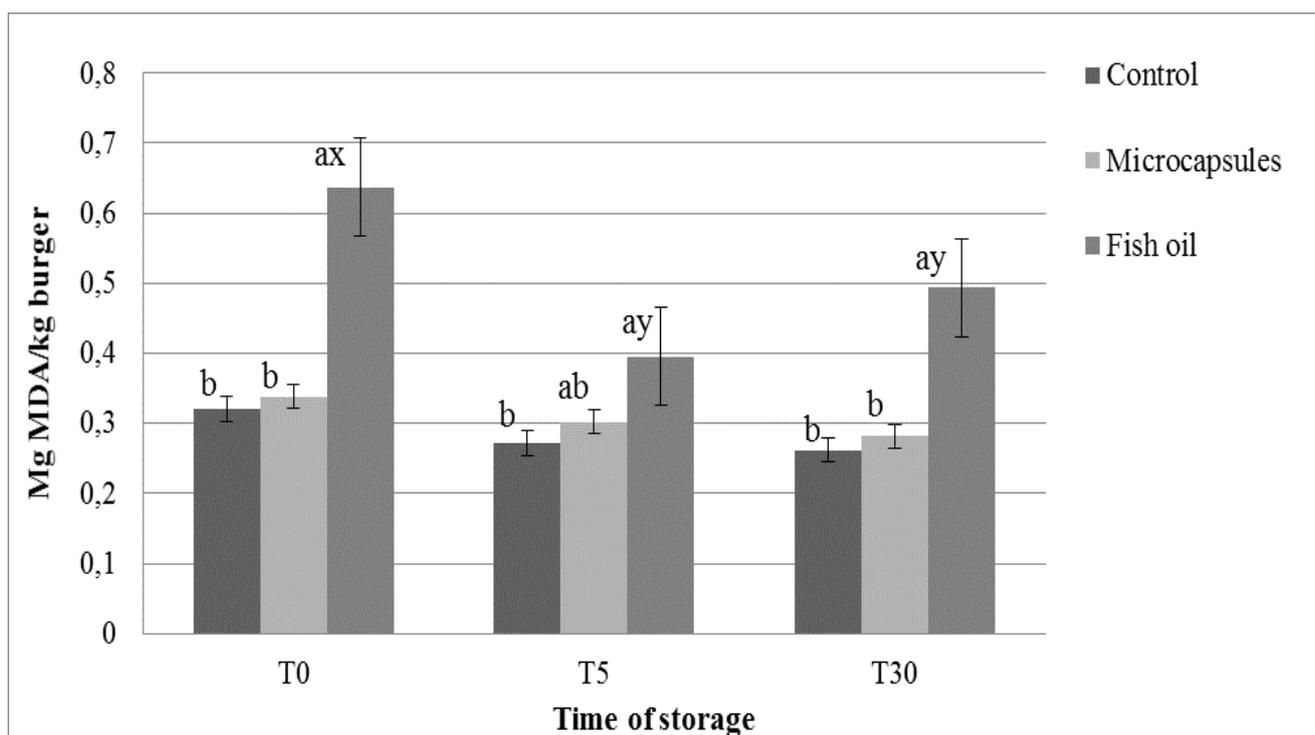


Figure 1. Lipid oxidation over addition and over storage. Different letters (a, b, c) within the same storage condition or among different storage condition (x, y) indicate significant differences (at least $P < 0.05$) (Ossidazione lipidica per metodo di addizione e modalità di conservazione. Lettere diverse (a, b, c) all'interno della stessa modalità di conservazione o tra diverse modalità di conservazione (x, y) indicano differenze significative (minimo $P < 0.05$)).

(2015, p. 82). In **Figure 1** are reported the TBARS results over addition and over storage. F samples resulted significantly more oxidized than C and M samples at T0 ($P < 0.001$), T5 ($P < 0.05$) and T30 ($P < 0.05$), as reported by Valencia et al. (2008, p. 1050) on fish oil added burgers. At T0 and T30, no significant differences were found between C and M, while at T5 M samples showed only slightly higher lipid oxidation values ($P < 0.05$). Similar results were also observed by Jiménez-Martin et al. (2015, p. 292) in enriched chicken nuggets.

CONCLUSIONS

In conclusion, fish oil microencapsulation technique appears to be an effective method to enrich meat in omega-3 fatty acids, protecting added PUFA from oxidation during the cooking. Sensory analysis will be carried out to test the consumer's acceptability of these products, taking into account that both the type of addition could have affected the burgers' organoleptic characteristics.

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