PE8.27 Oxidative and colour changes of cooked meat products formulated with different levels of tomato fibre 271.00

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***Abstract*—The effect of tomato fibre incorporation during refrigerated storage on lipid and protein oxidation and decolouration of cooked products manufactured with chicken, pork and beef was studied. The effect of the meat specie and the tomato level addition significantly affected the instrumental colour (CIE L*, a* and b*-values) of batters and cooked and refrigerated cooked products. The meat specie used for the manufacture of the batters and meat products significantly affected protein and lipid oxidation. The incoporation of tomato fibre to formula decreased lipid oxidation in batters and cooked products, although did not affect the formation of carbonyls. The incorporation of tomato fibre allows the enrichment in fibre of meat products protecting them against the alteration due to lipid oxidation.**

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***Index Terms*—oxidation, colour, meat, tomato fibre**

I. INTRODUCTION

The cooked meat products are common meat products in the diet because they are very appreciated by consumers. It is also an easy and economical way to obtain a high-value commodity from some meat remnants. However, their high fat content, especially in saturated fats, make that their frequent consume is associated with several diseases. Fat consume is considered a factor in the incidence of health problems such as coronary heart disease, obesity and certain types of cancers. Last recommendations of WHO/FAO [1] point the importance of a ‘‘balanced diet’’ with lower amounts of fat and higher level of fibre to avoid some chronic diseases. In addition, consumers are more conscious about nutritional aspects of the diet, as a consequence, industry is developing new products with more fibre and less fat content. Different strategies for the development of low fat content products can be used: reducing fat content of raw material or the substitution of fat by water or other ingredients in formulations such as fibre [2,3,4]. Dietary fibre is a group of food components, which is resistant to hydrolysis by human digestive enzymes and necessary for promoting good health. The presence of fibre in foods produces a diminution in their caloric content. Recently, bran cereal was the main source of fibre in food enriched with this component; however, the fibre from fruits and vegetables has better quality since it has a higher percentage of soluble fractions. Citrus by-products such as lemon albedo and orange fibre powder have been added to cooked and dry-cured sausages with very good results [5,6]. Other sources of fibre such as from apples, pears and peaches have been added to meat products with low fat content with interesting results [7,8].

Dietary fibre could be desirable for their nutritional properties but also for their functional and technological properties [9]. The substitution of fat by fibre in meat products increases functional properties, as decreases water loss and increases water-holding capacity; besides, it also modifies the texture and the colour of the meat products [7,8].

In many countries, tomato industry has great importance, which generates a huge amount of by-products. Parts of the fruits that are not used can be dried and milled being an adequate source of food fibre. In the case of tomato, this fibre is rich in lycopene- a major carotenoid of tomato- with an important colourant and antioxidant capacity. Different authors [10,11] proposed the use of these by-products as a source of food fibre rich in lycopene. Lycopene is the pigment mainly responsible for the characteristic deep-red colour of ripe tomato fruits and tomato products with important properties, particularly related to its effects as a natural antioxidant. Lycopene does exhibit a physical quenching rate constant with singlet oxygen almost twice as high as that of other natural antioxidants like beta-carotene so its presence in the diet is of considerable interest.

Tomato fibre was selected for this study as a potential ingredient for low-fat and fat-free processed meat products. Therefore, the objective of the present paper was to evaluate the addition of tomato fibre at different levels (0, 1 and 3% (w/w)) on lipid and protein oxidation and decolouration of beef, pork and chicken cooked meat products during refrigerated storage.

II. MATERIALS AND METHODS

A. Meat and dietary fibre

Commercially fresh chicken breasts, pork and beef were obtained from the central meat market.
Tomato fibre was obtained according Hernández, et al., (2000).

B. Title/Batter formulation, cooking and chilled storage

Chicken, pork and beef batters were prepared at three different levels of fibre addition (0%, 1%, 3%).
Fresh (4°C) meats were minced through a □ 4 mm plate using a meat mincer (Mainca, Maquinaria Industria, Carnica, Barcelona, Spain). Meat, water, salt and dietary fibres were chopped and mixed in a 5-L Stephan UMC 5 (Stephan Machinery GmbH; Hameln, Germany) for 5 min at 200 rpm at 4ºC. After mixing, batters (□50g) were placed into 50mL plastic tubes (5 tubes/treatment/day of storage) and cooked in a water bath to an internal temperature of 70ºC for 30 min. The cooked products were cooled in cold water for 10 min. Core temperature was measured and recorded using a temperature- K-type thermocouple sensor coupled to a data-logger (Data Harvest, UK).
To evaluate changes during refrigerated storage, samples were kept in closed plastic tubes under aerobic conditions and stored at +4ºC for 10 days.

C. Lipid oxidation

Lipid oxidation was assessed in duplicate by the 2-thiobarbituric acid (TBA) method of Salih et al [12]. TBA-RS values were calculated from a standard curve of TEP (1,1,3,3-tetraethoxypropane) and expressed as mg malondialdehyde/kg sample.

D. Protein oxidation

Protein oxidation was measured by estimation of carbonyl groups formed during incubation with 2,4-dinitrophenylhydrazine (DNPH) in 2 N HCl following the method described by Oliver et al [13]. Carbonyl concentration was measured on the treated sample by measuring DNPH incorporated on the basis of absorption of 21.0 mM^{-1} cm^{-1} at370 nm for protein hydrazones. Results were expressed as nmol of DNPH fixed per milligram of protein. Protein oxidation was expressed as nmol carbonyls/mgprotein. Protein concentration was calculated by spectrophotometry at 280 nm using bovine serum albumin (BSA) as standard.

E. Instrumental colour determination

Colour measurements were made following the recommendations on colour determination of the American Meat Science Association [14]. Instrumental colour was assessed before and after cooking the burgers. The following colour coordinates were determined: lightness (L*), redness (a*, red±green) and yellowness (b*, yellow±blue). Colour parameters were assessed using a Minolta CR-300 colourimeter (Minolta Camera, Osaka, Japan) with illuminant D65, a 0º standard observer and a 2.5 cm port/viewing area. The measurements were repeated at 3 randomly selected places on each sample and averaged.

F. Statistical analysis

A two-way Analysis of Variance with interaction procedure of SPSS, version 12.0 was applied [15]. Means were used to compare differences. HSD Tukey’s test was applied to compare the mean values

III. RESULTS AND DISCUSSION

The effect of the meat specie and the tomato level addition significantly affected the instrumental colour of batters and cooked products during refrigerated storage (Table 1) as significant differences were found in most of the parameters studied.
Chicken batters and cooked meat products at day 0 and 10 showed higher lightness (CIE L*-value) than pork batters and cooked meat products, while those from beef were the darkest. Beef batters had the highest redness (CIE a*-value), followed by pork and by chicken batters. However, cooked products at day 0 and 10 form beef and pork had higher redness than chicken ones. The yellowness (CIE b*-value) of batters was significantly higher in chicken and pork than in those batters manufactured from beef. However, after cooking after 0 and 10 days of refrigerated storage meat products with chicken had higher yellowness than those with beef or pork.
The level of addition of tomato fibre significantly affected instrumental colour of batters and meat

products. Batters without fibre and with 1% of tomato fibre showed higher lightness than batters with 3% of tomato fibre. Cooked products without tomato fibre at day 0 and 10 were lighter than those with 1% of tomato fibre while those with 3% of fibre had the lowest lightness. However, cooked products with 3% of tomato fibre showed highest redness (CIE a*), yellowness (CIE b*), followed by those with 1% of tomato fibre while those without fibre had the lowest values. In addition significant interactions were found between the type of meat and the level of fibre added.

Differences in colour parameters can be caused by the characteristics of the dietary fibre added to the meat products. So, the colour red-orange of tomato fibre is due to the presence of carotenoids, which produces this colour in these cooked meat products with tomato fibre and an increase of the values of CIE a* and b*-values.

Results of the effect of the type of meat used and the level of addition of tomato fibre to the batters and cooked products (day 0 and 10) are showed in Table 2. The meat specie used for the manufacture of the batters and meat products significantly affected protein and lipid oxidation levels. Beef batters had the highest levels of protein and lipid oxidation, followed by chicken batters while pork batters had the lowest levels. Pork cooked products at day 0 and 10 had higher carbonyls content than beef and chicken ones. However, chicken cooked products had highest MDA contents than beef and pork ones.

The level of addition of tomato fibre did not affect carbonyls content, but it reduced lipid oxidation extent. So, batters with 1 and 3% of tomato fibre had significantly lowest TBA-RS value than those without fibre. In non-refrigerated cooked products (day 0), those with no fibre had higher TBA-RS values than those with a 3% of fibre while those with 1% of fibre had intermediate levels. However, when patties were cooked after 10 days of refrigerated storage (day 10), the addition of 1% was no so effective to control lipid oxidation as significant higher levels of lipid oxidation were found in cooked products with no fibre and in those with 1% than in those products with 3% of tomato fibre.

Different papers have described the antioxidant activity of lycopene, which has described as a free radical scavenger [16, 17,18]. Our results show that tomato fibre had a high antioxidant activity that was effective in the control of lipid oxidation, and not on protein oxidation.

IV. CONCLUSION

Incorporation of tomato fibre (1 or 3%) for the manufacture of chicken, pork and beef cooked products is an effective way to control lipid oxidation after processing and during refrigerated storage, while protein oxidation is not affected by the addition of tomato fibre. Tomato fibre addition modifies the colour of both batters and cooked products, altering the normal colour of the products manufactured without tomato fibre. The incorporation of tomato fibre allows the enrichment in fibre of meat products protecting them against the alteration due to lipid oxidation.

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REFERENCES

[1] WHO. (2003). Diet, nutrition and the prevention of chronic diseases.Report of a Joint WHO/FAO Expert Consultation. WHO Technical.Report Series 916, Geneva.

[2] Claus, J.R. (1991) ‘Fat Reduction in Comminuted Meat Systems’. Reciprocal Meat Conf. Proc. 44,93-98

[3] Keeton, LT. (1991) ‘Fat Substitutes and Fat Modification in Processing’. Reciprocal Meat Conference Proceeding, 44, 79-91

[4] Jiménez-Colmenero, F. (1996). Technologies for developing low-fat meat products. Trends in Food Science and Technology, 7, 41-48

[5] Aleson-Carbonell, L., Fernández-López, J., Pérez-Álvarez, J. A., Kuri, V. (2005) Characteristics of beef burger as influenced by various types of lemon albedo. Innovative Food Sciences & Emerging Technologies, 6, 247-255.

[6] Fernández-López, J., Fernández-Ginés, J.M., Aleson-Carbonell, L., Sendra, E., Sayas-Barberá, E., & Pérez-Álvarez, J.A. (2004). Application of functional citrus by-products to meat products. Trends in Food Science & Technology, 15, 176–185

[7] Chang, H.-C., & Carpenter, J. A. (1997). Optimizing quality of frankfurters containing oat bran and added water. Journal of Food Science 62 (1), 194-197, 202.

[8] Grigelmo-Miguel, N, Abadías-Seró, M.I., & Martín-Belloso, O. (1999). Characterisation of low-fat high-dietary fibre frankfurters. Meat Science, 52, 247-256.

[9] Thebaudin, J. Y., Lefebvre, A. C., Harrington, M., & Bourgeois, C. M. (1997). Dietary fibres: nutritional and technological interest. Trends in Food Science and Technology, 8, 41–48.

[10] Sabio, E., Lozano, M., Montero de Espinosa, V., Coelho, V.J., Pereira, A.P., and Palabra, A.F. (2003) Lycopene and other carotenoids extraction from tomato waste using supercritical CO2. Ing. Eng. Chem. Res., 42:6641-6646

[11] Hernández, M.T., Lozano, M., Montero de Espinosa, V., Bernalte, M.J., Sabio, E., Castro, F.J. & Gervasini, C. (2000). Nuevo

producto a base de fibra de tomate, procedimiento para su preparación y aplicaciones. Patente española: P200001264. Junta de Extremadura.

[12] Salih, A. M., Smith, D. M., Price, J. F., & Dawson, L. E. (1987). Modified extraction 2-thiobarbituric acid method for measuring lipid oxidation in poultry. Poultry Science, 66, 1483–1489.

[13] Oliver C.N., Ahn B.W., Moerman E.J., Goldstein S. and Satadtman E.R. (1987). Aged-related changes in oxidized proteins. Journal of Biological Chemistry 262: 5488–5491.

[14] Hunt, M.C., Acton, J.C., Benedict, R.C., Calkins, C.R., Cornforth, D.P., Jeremiah, L.E., Olson, D.G., Salm, C.P., Savell, J.W., & Shivas, S.D. (1991). AMSA guidelines for meat colour evaluation. Proceedings 44th annual reciprocal meat conference. Chicago: National Livestock and Meat Board.

[15] SPSS (2003). Inc. SPSS 12.0 for Windows SPSS Inc. Chicago.

[16] Nagarajan, N., Hotchkiss, J.H. (1995). In vitro inhibition of N-nitrosomorpholine formation by fresh and processed tomatoes. Journal of Food Science, 64(6), 964-967.

[17] Tonucci, L.H., Holden, J.M., Beecher, G.R., Khachik, F., Davis, C.S., Mulokozi, G. (1995). *Journal of Agricultural and Food Chemistry*, 43(3), 579-586.

[18] Gartner, C., Stahl, W., Sies, H. (1997). Lycopene is more bioavailable from tomato paste than from fresh tomatoes. *American Journal of clinic nutrition*, 66, 116-122.

Table 1- Effect of meat (chicken, beef, pork) and level of addition of tomato fibre (0%,1% and 3%) on instrumental colour of batters and cooked products during refrigerated storage (day 0 and day 10).

	Type of meat			Level of addition (w/w)				Effects (significance)		
	Chicken	Beef	Pork	0%	1%	3%	SEM	1	2	3
Batter										
CIE-L*	59.74 a	46.05 c	53.67 b	54.97 a	54.29 a	50.20 b	1.203	***	***	***
CIE-a*	9.53 c	28.82 a	22.08 b	16.22 c	20.38 b	23.89 a	1.399	***	***	***
CIE-b*	22.95 a	19.81 b	21.84 a	11.97 c	22.91 b	29.71 a	2.287	***	***	***
Cooked (day 0)										
CIE-L*	78.11 a	54.35 c	62.98 b	67.93 a	65.41 b	62.10 c	0.832	***	***	***
CIE-a*	5.56 b	10.28 a	10.58 a	7.70 c	8.53 b	10.19 a	0.775	***	***	***
CIE-b*	16.01 a	13.45 b	13.36 b	8.50 c	13.69 b	20.62 a	2.077	***	***	*
Cooked (d 10)										
CIE-L*	78.00 a	54.29 c	63.16 b	68.50 a	65.02 b	61.92 c	0.797	***	***	*
CIE-a*	5.78 b	10.55 a	10.64 a	7.92 c	8.93 b	10.11 a	0.752	***	***	***
CIE-b*	15.65 a	13.33 b	13.94 b	8.69 c	13.58 b	20.65 a	1.789	***	***	***

a,b,c: Different letters denote statistical differences for type of meat and tomato fibre addition (Tukey's test, $p<0.05$). SEM: standard error of the mean. Effects: 1: type of meat; 2: level of addition of tomato fibre; 3: interaction

Table 2.- Effect of meat (chicken, beef, pork) and level of addition of tomato fibre (0%,1% and 3%) on protein oxidation (nM carbonyls/mg protein) and lipid oxidation (mg MDA/kg sample) of raw batters, and cooked products during refrigerated storage (day 0 and day 10).

	Type of meat			Level of addition (w/w)				Effects (significance)		
	Chicken	Beef	Pork	0%	1%	3%	SEM	1	2	3
Batters										
Carbonyls	1.17 b	1.98 a	0.81 b	1.49	1.19	1.29	0.108	***	ns	ns
TBA-RS	0.22 b	1.20 a	0.11 c	0.55 a	0.48 b	0.49 b	0.075	***	***	***
Cooked (day 0)										
Carbonyls	1.62 b	1.09 b	3.32 a	2.22	1.95	1.85	0.140	***	ns	ns
TBA-RS	2.20a	1.78b	1.99b	2.26 a	2.06 ab	1.65 b	0.043	***	**	ns
Cooked (day 10)										
Carbonyls	1.59 b	1.17 b	4.16 a	2.53	2.18	2.22	0.273	***	ns	ns
TBA-RS	3.10 a	2.53 b	2.74 b	3.06 a	2.92 a	2.39 b	0.074	***	***	**

a,b,c: Different letters denote statistical differences for type of meat and tomato fibre addition (Tukey's test, $p<0.05$). SEM: standard error of the mean. Effects: 1: type of meat; 2: level of addition of tomato fibre; 3: interaction