PHYSICAL, CHEMICAL AND SENSORY QUALITY IN RABBIT BURGERS, REFRIGERATED AND STORED UNDER DIFFERENT CONSERVATION METHODS

Cossu M. E.*, Lamanna M. L., Picallo A. B., Cumini M. L., Gambetti P., Lazzari G.
Dto. Prod. Animal. Facultad de Agronomía, Univ. de Buenos Aires. Av. San Martín 4453, Buenos Aires, Argentina.
*Corresponding author: mcossu@agro.uba.ar

ABSTRACT

The high quality and safety of raw meat products are important features to be conserved during the storage and distribution. Nowadays, processed products are very popular; however, not enough studies have been carried out to assess rabbit meat burgers quality. In order to introduce rabbit meat into the market of processed meat and verify the best method of packaging that prevents lipid and pigment oxidation, chilled (2±1 °C) burgers, packed without or with vacuum (Multivax) or modified atmosphere (30% CO_2-70% N_2, MAT) stored in dark (refrigerated chamber) or under fluorescent light (commercial fridge) were analysed at 1, 2, 5, 9, 13 and 15 days after preparation (6 hamburgers/packet/day/dark-light storage). Lipid oxidation (TBARS index), raw color (CIELAB system), and pH (Testo205) were determined. Fatty acids were analysed as methyl esters by gas chromatography. Refrigeration and cooking (grill, 71±1 ºC) losses were determined by weight difference. Cooked burgers were also analysed by an analytical panel of 8 trained assessors for overall color, off-odours, flavour and off-flavour. The place of storage influenced b* and C* values (higher in dark refrigeration room) and raw and cooked TBARS (higher under light incidence). Packaging and time influenced physical and sensory quality of burgers until 15 days of storage. The longer time of conservation increased values of the b* parameters, TBARS and water losses. Off-odours/off-flavours increased after 9 days of storage but their perception was low, especially for vacuum-packed burgers. Fatty acid profile was not influenced by place, packaging and time. In conclusion, the light/dark storage showed similar effects on the sensory qualitative traits of burgers while the physical quality was mainly influenced by light incidence, vacuum or MAT packaging and storage time.

Key words: Processed meat, rabbit, vacuum, modified atmosphere, light.

INTRODUCTION

Today's consumers are more concerned with the qualitative characteristics of food, causing a growing demand for more selective food and an increasing need of its differentiation. Consumers demand high quality meat products with natural flavour and tasted (Hugas *et al*., 2002) but also ask for no time-consuming food preparation. The food industry offers a wide range of meat products quick and easy to cook. The presentation of the meat as hamburgers is the most widespread industrial product. The main problem associated with the commercialization of hamburger is their shelf life. An approach to overcoming the problem of limited shelf life is to use vacuum packaging; moreover, the modified atmosphere (MAT) packaging is known as a method for extending shelf-life of meat products (Tremonte *et al.,* 2004; Mohamed *et al*., 2008). These systems of conservation have not been widely studied on rabbit meat (Berruga *et al*., 2005).

The consumption of rabbit meat in Argentina is very low (100g/inhabitant/year; SENASA -Servicio Nacional de Seguridad y Calidad Agroalimentaria- Argentina); and fluctuations in the export market of this meat is forcing breeders to look for the development of a domestic market demand of 'easy preparation' meals such as hamburgers.

During retail display the packet is exposed to light (incandescent or fluorescent); the perceived color of meat varies with the spectral profile of the incident light. Light promotes metmyoglobin formation through photochemical autoxidation that is slightly temperature dependent; in chilled meat, light-induced discoloration is less than thermally induced discoloration (Andersen *et al.*, 1989). Nonetheless, fluorescent display light does promote discoloration of chilled meat.

The objective of this research was to assess the effects of packaging (vacuum-packed or MAT) and place of conservation (light or dark) on the eating quality of refrigerated rabbit meat hamburgers until 15 days of conservation.

MATERIALS AND METHODS

Hamburgers were prepared from rabbit meat (loin and thigh) slaughtered at commercial weight (2.3-2.5 kg). Chilled burgers (refrigerated at 2±1°C), film wrapped (Control; C), with vacuum packaging (Multivax; Cryovac pouches of 60 microns; V) or with modified atmosphere (30%CO_2-70%N_2; MAT) storage at a commercial fridge (with fluorescent light) or at a refrigerated chamber (dark condition) were analysed at 0, 2, 5, 9, 13 and 15 days after preparation (6 hamburgers/packet/day/dark-light storage). Lipid oxidation (TBARS index; µg of malonaldehyde/g meat; Robards *et al.*, 1988), raw color (CIELAB System: L* (lightness), a* (redness), b* (yellowness) and C* as $\gamma(a^{*2} + b^{*2})$; Minolta Chroma Meter-CR300) and pH (Testo 205) were determined. Fatty acids were extracted (Folch *et al.*, 1957) and analysed as methyl esthers by gas chromatography (Shimatzu 14-B, capillary column Resteck 2560) at 0, 5 and 15 days.

The burgers were cooked in a double contact grill to reach 71±1ºC in the centre of the sample (cold point), monitored by thermocouples. Cooking losses were determined by weight difference. Raw burgers were analysed by an analytical panel of 8 trained assessors according to international standards and experience in meat sensory analysis (ISO 1987, 1992, 1993, 1994). The following descriptors were assessed: color, off-odour, flavour/off-flavour and juiciness, using an unstructured linear scale of 10 cm without anchorage. The ends of the scales corresponded to the intensity of the attribute: light pink, extremely soft and dry (lower limit: 0) and red, very strong and juicy (upper limit: 10).

Statistical analysis of data was performed using the Proc Mixed of SAS (2004) for repeated measurements. Differences between treatments were analysed by Tukey test ($p < 0.05$).

RESULTS AND DISCUSSION

For raw hamburgers, the packaging and the storage time showed a clear influence on color, lipid oxidation, cooking losses and sensorial parameters, hardly explained by a single factor due to the interaction among them (Table 1); instead of this, the place of storage (dark or fluorescent light) determined higher b*and C* parameters and less TBARS values in dark respect light conditions, but it did not show any influence on the analysed sensory qualitative traits.

The vacuum-packed burgers resulted in higher redness but less luminosity, yellowness and chroma while MAT burgers showed less pH and lipid oxidation in raw and cooked burgers. Water losses were lower in control than in V and MAT. The pH and L* values decreased up to 5 days and then increased reaching the initial values at 15 days of storage. The b* parameter, water losses and lipid oxidation increased at longer storage time while the lower storage resulted in less luminosity, a* and chroma parameters.

For sensorial parameters, the vacuum-packed burgers showed less off-odour and off-flavour than the control and MAT ones. Off-color and off-flavour parameters increased with storage time; at 15 days, the burgers were less colorful and fragrant; the off-parameters increased after 9 days of conservation reaching, however, to values lower than 2 in a 1-10 scale.

Table 1. Effect of storage place, packaging and storage time on cooking loss, pH, color, TBARS and sensory parameters of rabbit hamburgers

Traits	Place (P)		Packaging (Pk)**			Days (D)						Probability					SE
	With light	No light	C	V	MAT	0	2	5	9	13	15	P	Pk	D	Pk x D	P x Pk xD	
pH	5.71	5.71	5.72^{a}	5.72^{a}	5.70^{b}	5.74^{z}	5.67^{u}	5.70^{v}	5.72^{xy}	5.73^{yz}	5.71^{xw}	NS	<0.01	<0.01	NS	<0.05	0.02
L*	61.5	61.6	63.0^{c}	60.1^{a}	61.6^{b}	62.6^{v}	61.4^{u}	60.6^{u}	60.9^{u}	61.6^{u}	62.9^{v}	NS	<0.01	<0.01	<0.01	NS	1.94
a*	9.23	9.27	7.61^{a}	12.6^{b}	7.50^{a}	11.2^{x}	10.1^{w}	10.7^{wx}	9.03^{v}	7.85^{u}	7.52^{u}	NS	<0.01	<0.01	<0.01	<0.01	1.35
b*	11.0	11.5	13.6^{c}	7.33^{a}	13.1^{b}	10.2^{u}	10.6^{u}	11.1^{v}	11.5^{v}	11.9^{v}	11.9^{v}	<0.01	<0.01	<0.01	<0.01	<0.01	1.14
C*	14.4	14.8	15.9^{c}	14.8^{a}	15.1^{b}	15.5^{u}	14.4^{u}	16.1^{v}	14.9^{u}	15.3^{u}	15.4^{u}	<0.01	<0.01	<0.01	<0.01	<0.01	1.46
TBARS, μg/g:																	
Raw	5.84	5.55	7.90^{c}	6.65^{b}	5.86^{a}	2.46^{u}	5.67^{u}	5.39^{u}	5.70^{v}	5.96^{v}	9.00^{w}	<0.01	<0.01	<0.01	<0.01	<0.01	0.62
Cooked	9.03	8.32	11.0^{b}	12.4^{c}	8.79^{a}	9.12^{y}	7.94^{v}	8.64^{w}	7.09^{u}	9.00^{x}	10.3^{z}	<0.01	<0.01	<0.01	<0.01	NS	0.51
Water losses, %																	
Refrigeration	0.70	0.73	0.59^{a}	0.72^{c}	0.64^{b}	0.38^{u}	0.56^{v}	0.62^{v}	0.83^{w}	0.80^{w}	0.96^{x}	NS	<0.01	<0.01	NS	<0.01	0.13
Cooking	17.2	17.7	16.1^{a}	16.1^{a}	17.3^{b}	9.8^{u}	11.6^{v}	14.4^{w}	18.5^{x}	20.4^{y}	21.5^{z}	NS	<0.01	<0.01	<0.01	<0.01	0.75
Color*	4.9	5.1	4.9	5.1	5.0	5.3^{u}	6.4^{v}	5.0^{u}	4.4^{u}	4.5^{u}	4.7^{u}	NS	NS	<0.01	NS	NS	1.17
Off- odour	0.3	0.5	0.6^{b}	0.2^{a}	0.5^{b}	0.2^{u}	0.4^{uv}	0.2^{u}	0.3^{uv}	0.8^{v}	0.8^{v}	NS	<0.01	<0.01	NS	NS	0.76
Flavours	5.5	5.3	5.6	5.5	5.2	6.0^{w}	4.8^{uv}	5.6^{wv}	6.1^{w}	5.2^{wv}	4.3^{u}	NS	NS	<0.01	NS	NS	1.39
Off- flavours	1.1	1.1	1.3^{b}	0.8^{a}	1.1^{ab}	0.4^{u}	0.3^{u}	0.5^{u}	1.8^{v}	1.7^{v}	1.8^{v}	NS	<0.05	<0.01	<0.01	NS	1.04

**Packaging: C: control, V: under vacuum, MAT: modified atmosphere; *Color: sensorial attribute; a, b, c: p<0.01 for packaging; u, v, w, x, y, z: p<0.01 for days of storage; NS: not significant.

In the fatty acids profile of rabbit burgers (Table 2), the packaging was the only factor that determined slightly differences in some of the FA while the incidence of light or dark conditions and the time of storage did not influence the intramuscular FA profile until 15 days. Vacuum-packed and MAT burgers showed more linolenic FA (p<0.05) and lower n-6/n-3 ratio (p<0.10) than control burgers. From 1 to 15 days of storage, burgers showed a general, non-significant decrease of n-6/n-3 ratio that resulted in a higher value than the one consider optimum for human consumption (Holman, 1995) without any change in the SFA and UFA.

Table 2. Effect of conservation place, packaging and storage time on fatty acids profile (%total FAME) of rabbit burgers

	Place (P)		Packaging (Pk)*			Days (D)			Probability				S.E.
Traits	With light	No light	C	V	MAT	0	5	15	P	Pk	D	Inter. PxPkxD	
C 16:0	28.7	28.4	29.5	26.8	29.3	28.8	28.4	28.5	NS	NS	NS	NS	2.33
C 18:0	6.41	6.45	6.58	5.93	6.77	6.62	6.10	6.56	NS	NS	NS	NS	0.57
C18:1 *n*-9	26.4	25.6	27.0	24.4	22.7	25.8	26.1	26.1	NS	NS	NS	NS	1.72
C18:2 *n*-6	22.6	22.2	21.2	23.9	22.2	22.4	22.7	22.2	NS	NS	NS	NS	2.11
C18:3 *n*-3	1.44	1.35	1.24^{a}	1.54^{b}	1.39^{ab}	1.44	1.34	1.40	NS	<0.05	NS	NS	0.16
C20:4 *n*-6	1.29	1.63	1.26	1.83	1.29	1.60	1.39	1.39	NS	NS	NS	NS	0.66
C20:5 *n*-3	0.08	0.26	0.18	0.10	0.21	0.10	0.14	0.25	NS	NS	NS	NS	0.17
C22:5 *n*-3	0.15	0.26	0.19	0.30	0.13	0.14	0.32	0.16	NS	NS	NS	NS	0.23
C22:6 *n*-3	0.11	0.12	0.08	0.20	0.07	0.05	0.16	0.14	NS	NS	NS	NS	0.09
SFA[1]	39.5	39.3	40.3	37.6	40.2	39.7	38.9	39.5	NS	NS	NS	NS	2.63
MUFA[2]	33.6	33.7	34.2	33.2	33.5	33.6	33.8	33.5	NS	NS	NS	NS	1.14
PUFA[3]	26.6	26.7	25.1	28.8	25.9	26.3	26.9	26.6	NS	NS	NS	NS	2.95
n-6/n-3	11.7	10.9	12.1	10.6	11.3	13.3	10.0	10.6	NS	NS	NS	NS	2.24
T.I.[4.]	0.81	0.81	0.84	0.76	0.83	0.80	0.82	0.82	NS	NS	NS	NS	0.08

SFA[1] saturated fatty acids; MUFA[2] monounsaturated fatty acids; PUFA[3] polyunsaturated fatty acids; T.I.[4]: thrombogenic index.*C: control, V: under vacuum; MAT: modified atmosphere; SE: standard error; a,b: p<0.05.

CONCLUSION

From a sensorial point of view, the place of storage did no influence the panelist evaluation. Up to 15 days of storage, both off-odour and off-flavour perception were very low. In conclusion, dark conditions and vacuum and modified atmosphere packaging showed better qualitative traits than control conditions. The light/dark storage did not influence sensorial quality of burgers.

REFERENCES

Andersen H.J., Bertelsen G., Skibsted LH. 1989. Color stability of minced beef. Ultraviolet barrier in packaging material reduces light-induced discoloration of frozen products during display. *Meat Science. Vol 25(2:155-159.*

Berruga M.I., Vergara H., LinaresM.B. 2005. Control of microbial growth and rancidity in rabbit carcasses by modified atmosphere packaging. *J. Sci. Food Agric. 85*: *1987-1991*.

Folch J., Lees M., Sloane S.G.H. 1957. A simple method for the isolation and purification of total lipids from animal tissues. *Journal of Biological Chemistry. 226:. 497-509.*

Hugas M., Garriga M., Monfort J.M. 2002. New mild technologies in meat processing: high pressure as a model technology. *Meat Sci. 62: 357-371.*

Holman R. 1995. Essential fatty acids in health and disease. Actas de las jornada de actualización: las carnes en la nutrición y la salud humana. Academia Nacional de Medicina. Pgs.: 120-124; 2-3 June 1995.

ISO5496:1992. Sensory Analysis - .Methodology - Initiation and training of assessors in detection-recognition of odours

ISO 4121:1987. Sensory Analysis - Methodology - Evaluation of products by methods using scales

ISO8586-1:1993 Sensory analysis-General guidance for the selection, training and monitoring of assessors- Part1: Selected assessors.

ISO 11036:1994 Sensory analysis. - Methodology - Texture Profile.

Mohamed A.,Jamilah, B., Abbas K.A., Abdul Rahman R. 2008. A review on some factors affecting colour of fresh beef cuts. *J. of Food, Agriculture & Environment. Vol. 6 (3&4): 76-81*.

Robards K., Kerr A., Patsalides E. 1988.Rancidity and its measurement in edible oils and snack food: a review.*Analyst 113*: *213-224*

Tremonte P., Sorrentino E., Succi M., Di Renzo T., Reale A., Maiorano G., Coppola R. 2004. Microbiological quality of fresh meat products stored under modified atmospheres. *50th ICoMST*, Helsinki, Finland.