Comparative effects of packaging and ageing on shelf life of chicken and rabbit hamburgers

Cossu M.E.; Picallo A.B., Lamanna M.L.; Lazzari G.; Cumini M.L.; Vello V.; Raffaeli F.

Department of Animal Production. Faculty of Agronomy, University of Buenos Aires. 4453 San Martín Av., Ciudad de Buenos Aires, Argentina. mcossu@agro.uba.ar

Abstract— **In order to introduce rabbit meat as an alternative to poultry in the market of processed meat and verify the best method of packaging that prevents lipid and pigment oxidation, chilled (4°C±1) rabbit and chicken hamburgers, packed with vacuum or modified atmosphere (30%CO_2-70%N_2) were analyzed after 0-3-5-9 days of elaboration. Lipid oxidation, raw/cooked pH and colour were measured. Cooking losses were determined by weight difference (grill, 71±1ºC) and then analyzed by an analytical panel of 8 trained assessors while 160 consumers evaluated the acceptability and preference on the 3rd day. Statistical analysis was performed using the Proc Mixed of SAS for repeated measurements. For raw and cooked hamburgers, neither the origin of the meat, nor the packaging or the cooling time showed a clear influence on colour parameters, lipid oxidation and cooking losses due to the interaction between all the factors. Rabbit burgers were more 'red' and chicken burgers more 'yellow' but the luminosity was similar; the TBAR value was significantly higher in rabbit meat. Chicken/rabbit origin had more influence than packaging or cooling time on sensory analysis. The off-odour/flavour was negligible until 9 days of ageing. The acceptability test showed a normal distribution between 'I like'/'I dislike'; the preference test showed 'vacuum rabbit burger' as the most selected at day 3. As a conclusion, refrigerating conditions showed good physical and sensory qualities of chicken/rabbit hamburgers up to 9d of storage. Three days 'vacuum rabbit burger' was the preferred selection of consumers.**

Keywords—**burgers, white meat, acceptability/ preference.**

I. INTRODUCTION

As consumers are becoming conscious of their diets and the impact on their health, there has been a shift to eating white meat for its low fat level. Also, the current consumers show preference for food that allow them to reduce meal preparation time. The Argentine annual consumption of chicken meat is 36 kg/*capita* while rabbit meat is very low (100g *per capita*; *Servicio Nacional de Seguridad y Calidad Agroalimentaria- Argentina*) as the majority of the production is exported. Fluctuations of the export market for this meat is forcing breeders to look for the development of a domestic market demand for easy meal preparation such as hamburgers. The degree of industrialization of rabbit meat in Argentina is emerging. In general for meat products, there is a strong interest in increasing the shelf life, but prolonged preservation methods alter the physico-chemical, nutritional and sensory properties. One approach to overcoming the problem is to use vacuum or modified atmosphere packaging in order to maintain a fresh appearance, reduce microbial growth and oxidation of lipids and pigments in refrigerated processed meats [1] [2] [3] [4]. The objective of this study was to examine the introduction of rabbit meat, as an alternative meat to the traditional chicken, and verify the best method of packaging to extend the shelf life of rabbit or chicken meat as burgers presentation.

II. MATERIALS AND METHODS

Hamburgers were prepared from rabbit and chicken meat 24 hours after slaughter (New Zeland x California rabbits, 80 days and 2,400kg slaughter weight and Cobb line chickens, 42 days and 2,5 live weight at slaughter). Chilled burgers ('C', commercial refrigerator at 4°C±1), packed with vacuum ('V', Multivax; Cryovac pouches of 100 microns) or modified atmosphere ('MAT'; 30%CO_2-70%N_2) were analyzed after 0-3-5-9 days of elaboration (16 hamburgers / meat source / packing / days). Lipid oxidation (TBAR's index; µg of malonaldehíde /g meat) [5], colour (CIELAB System, L* (lightness), a* (redness), b* (yellowness) and C* as $\sqrt{(a^{*2}+b^{*2})}$), using a Minolta Chroma Meter-CR300 and pH (Testo

205) were determined. The burgers were cooked in a double contact grill to reach 71ºC ± 1ºC in the centre of the sample (cold point), monitored by thermocouples. Cooking losses were determined by weight difference. Chicken and rabbit burgers were analyzed by an analytical panel of 8 trained assessors according to the international standards and experience in sensory analysis of meat [6] [7] [8] [9] [10]. Each assessor received samples (1x1x1cm cubes) in containers coded with three digit random numbers. The following descriptors were assessed: colour, odour/off odour, flavour/off flavor, and juiciness, using an unstructured linear scale of 10 cm without anchorage. The ends of the scale corresponded to the intensity of the attribute: light pink/white, extremely soft, dry, (lower limit: 0) and red/yellow, very strong and juicy (upper limit: 10). One hundred and sixty consumers evaluated the acceptability and preference on the 3rd day; consumers ate samples of all burgers evaluating acceptability (7 choices from 'I dislike very much' to 'I really like') and preference between meat source and packaging and ageing time. Statistical analysis of data was performed using the Proc Mixed of SAS [11] for repeated measurements. Differences between treatments were analyzed by Tukey test ($p < 0.05$).

III. RESULTS AND DISCUSSION

For raw hamburgers, neither the origin of the meat (rabbit/chicken), nor the packaging (with or without vaccum, MAT) or the cooling time showed a clear influence on pH, colour parameters and cooking losses due to the interaction between all factors (table 1). In chicken burgers, the packaging 'under vacuum' resulted in less luminosity (L*: 60.2 *vs* 61.2 for C and MAT) and chroma (C*: 18.4 *vs* 20.3 for C and MAT) while in rabbit, control burgers were more coloured and brighter than vacuum and MAT (L*: 62.7 *vs* 60.8 V and MAT; C*: 16.4 *vs* 14.2 V and MAT) packaging. The luminosity decreased in raw meat (Chicken L* 0d: 62.4 *vs* 9d: 59.9 and Rabbit L* 0d: 62.5 vs 9d: 60.6) at longer storage time while colour parameters increased (Chicken C* 0d: 18.7 *vs* 9d: 20.7 and Rabbit C* 0d: 14.5 vs 9d: 15.0). The pH values only decreased in V and MAT (5.91 *vs* 5.86) chicken burgers.

Table 1 Effect of packaging and ageing on pH, colour and water losses of chicken and rabbit burgers

Item	Chick. burger	Rabbit burger	Probability Meat	Pack	Time	MxPxT	St.e.
pH raw	5.86	5.23	<.0001	.5130	<.0801	.4393	0.06
L* raw	60.9	61.4	.0128	<.0001	<.0001	.0326	1.65
C* raw	19.7	14.9	<.0001	<.0001	<.0001	.0082	1.51
Refr.loss	0.50	0.55	.2583	.0134	.0340	.8262	0.33
pHcook	6.07	6.00	<.0001	<.0001	<.0001	.0001	0.01
L* cook	80.4	75.4	<.0001	<.0001	<.0001	.0005	1.14
C*cook	18.0	14.1	<.0001	<.0001	<.0001	.0001	0.78
CookLoss	14.9	14.7	.2721	<.0001	<.0001	.0001	1.52

For cooked burgers, meat origin, packaging and storage time significantly influenced the pH, losses and colour parameters. Luminosity was higher while pH and chroma decreased at longer storage time. Control rabbit burgers showed higher luminosity and chroma (L*: 77.7 and C*:14.4) than V and MAT (L*: 74.4 and C*:13.6)

Fig. 1 Effect of packaging and ageing on raw chicken burgers Tbar's

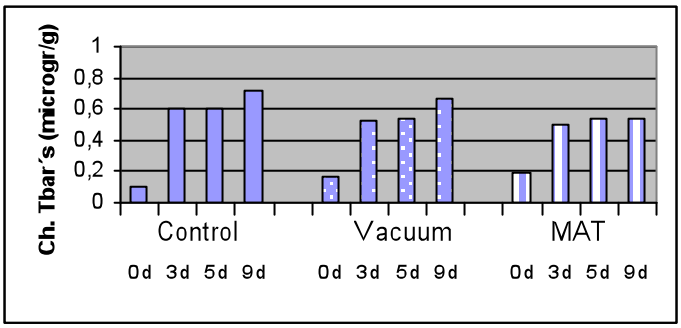
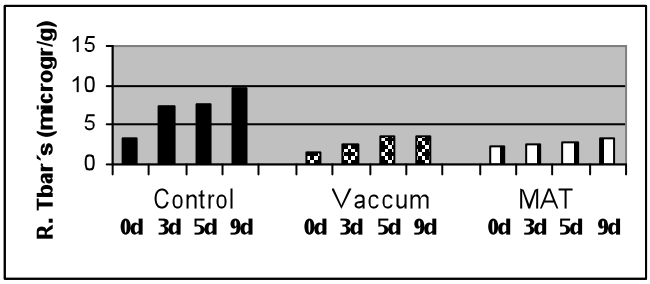


Fig. 2 Effect of packaging and ageing on raw rabbit burgers Tbar's



The TBAR value (Fig. 1 and 2) was significantly higher in rabbit burgers (4.4 *vs* 0,5µg/g in chicken;

p<0.0001) probably due to different lipid (EE: 14.4% d.m. and 4.59% d.m. in rabbit and chicken meat) and poliunsaturated fatty acids content with more n-3FA in rabbit meat. In both types of meat, rabbit and chicken, oxidation increased with the longer time of cooling, especially in control burgers (p<0.0001). The packaging under vacuum and MAT showed an effective protection against lipid oxidation of rabbit burgers (6,9 *vs* 2,8 μg/g for control and V/MAT packaging; p<0.0134).

Table 2 Effect of packaging and ageing on sensory quality of chicken and rabbit burgers

Item	Chicken burgers		Rabbit burgers		Probability				St.
	0d	9d	0d	9d	Meat	Pack	Time	MxPk	error
Colour	4.1	3.8	4.7	4.5	.0001	.5229	.0411	.094	1.5
Odour*	4.3	5.7	6.0	5.9	.0041	.6179	.0429	.041	1.4
Off Od.	0.0	0.8	0.1	0.2	.0845	.0068	.0030	.073	0.4
Flavour*	5.1	6.7	6.6	6.6	.0002	.2956	.0035	.090	1.6
Off Flav	1.6	2.3	0.6	1.5	.0007	.3044	.0055	.595	1.2
Juiciness	3.6	1.5	3.6	3.7	.0001	.5807	.0035	.001	1.3

*'chicken' and 'rabbit' odour/flavour

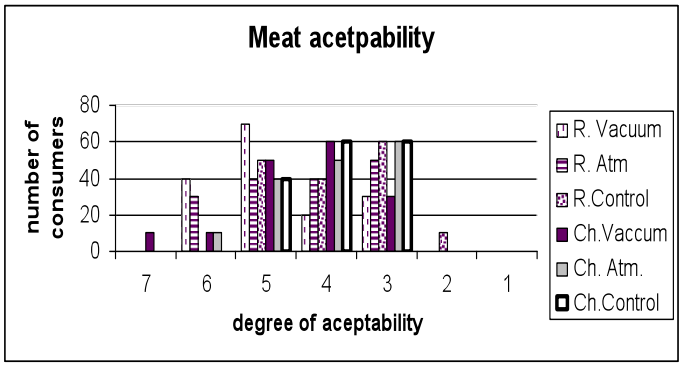
Chicken/rabbit origin had more influence than packaging on sensory analysis (table 2). The sensory characteristics of rabbit burgers were stable during the storage. Chicken burgers increased the characteristic chicken-taste and the off-flavour and decreased the juiciness with the cooling time. In both types of meat, the off-odour and off-flavour were negligible until 9 days of ageing.

The acceptability test (fig. 3) showed a normal distribution between 'I like'/'I dislike' (degree 3, 4 and 5); in the extreme positive degrees, 6 and 7 , only V and MAT burgers were found. The preference test showed 'vacuum rabbit burger' as the most selected at day 3.

IV. CONCLUSIONS

The origin of the meat, the packaging system and the storage days, showed a strong interaction between them on the physical parameters, while sensory quality was mainly influenced by the type of meat and time. As a conclusion, refrigerating conditions showed good physical and sensory qualities of chicken/rabbit hamburgers up to 9 days of storage. The burgers packed under vacuum or modified atmosphere showed higher degree of acceptance regarding the control on the third day of storage. Three days 'vacuum rabbit burger' was the preferred selection of consumers**.**

Fig. 3 Effect of packaging on chicken and rabbit burgers aceptability on day 3 of ageing



Degree of aceptability: 1: 'I really dislike very much'; 2 'I dislike very much'; 3 'I dislike' ; 4: 'I don´t dislike-I don´t like'; 5: 'I like; 6: 'I like very much'; 7: 'I really like very much'.

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