EXAMINATION OF THE MEAT QUALITY OF GROWING RABBITS REARED ON WIRE NET OR COMBINED (WIRE NET / STRAW) FLOOR AT DIFFERENT STOCKING DENSITIES

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***Abstract*—The aim of the study was to evaluate the effect of the cage floor-type and stocking density on the rabbit meat quality. Weaned rabbits were placed to 12 pens, each having a basic area of 50×170 cm. The pens differed only in the type of floor. Six pens had a wire net, six pens a combined (half of the floor wire net and half of the floor straw litter) floor. On both floor types (wire net and combined) three stocking densities (8, 12 and 16 rabbits/m^2) were applied. The experiment took place between the ages of 5 and 11 weeks. At 11 weeks of age the animals were slaughtered and hind leg (HL) and loin meat were dissected and analysed for pHu, L*a*b* colour values, proximate composition and fatty acid profile. Compared to wire net floor the combined floor significantly increased the b* colour value of *Biceps femoris* (BF) muscle and the a* colour value of *Longissimus dorsi* (LD) muscle, whereas the pHu and the fat content of LD muscle decreased. Combined floor reduced MUFA ($P<0.05$) of both HL and LD meat, and increased PUFA content ($P<0.05$) of LD meat. At the intermediate stocking density of 12 rabbits/m^2, the LD meat showed lower CLA and higher DHA fatty acid contents ($P<0.01$) than the other two extreme stocking densities.**

***Index Terms*— rabbit, cage floor-type, meat quality.**

I. INTRODUCTION

In animal husbandry the requirement of efficient and safe production, taking animal welfare and environmental viewpoints into account, is gaining importance world-wide. During the last years also the consumers' demands changed substantially and the meat originated from animals kept under (semi)natural conditions is favoured. From an animal welfare aspect the most often mentioned problems concern the too high stocking density and the restriction of free locomotion. For this reason recent studies on rabbit rearing were focused on the development of alternative housing systems, which could increase the animal comfort and welfare. The application of deep litter and the rabbit rearing in relatively large groups were suggested during fattening (Verga, 2000). However, under these circumstances rabbits achieve the slaughter weight later (Dal Bosco, Castellini, Mugnai, 2002; Kustos, Tóbiás, Kovács, Eiben, Szendrő, 2003), and the risk of coccidiosis (Kustos *et al*., 2003) and the occurrence of injuries related to aggressive behaviour are higher (Princz, Romvári, Szabó, Metzger, Radnai, Biró-Németh, Orova, Nagy, Szendrő, 2006). In this study it was examined the meat quality of rabbits submitted to alternative rearing systems: in pens on wire net or on combined floor, at different stocking densities.

II. MATERIALS AND METHODS

One hundred twenty-four rabbits (Pannon White breed) of both sexes were used. Animals were kept between the ages of 5 to 11 weeks in a closed building with a temperature of 16-17 ºC using a lighting regime of 16L/8D. They were placed to 12 pens, each having a basic area of 50×170 cm. The pens differed only in the type of floor. Six pens had a wire net whereas six pens were provided with a combined floor: half of wire net and half of straw litter. On both floor types (wire net and combined) three stocking densities (8, 12 and 16 rabbits/m^2) were applied. Weaned rabbits consumed medicated pellets up to the age of 9 weeks (14.5% crude protein, 17.5% crude fibre, 2.0% ether extract, 10.3 MJ DE/kg, 50 000 mg/kg Tilmikozin and 0.025% Pulmotil 200). Thereafter they received, *ad libitum*, a non-medicated pellet (16.0% crude protein, 16.0% crude fibre, 3.0% ether extract, and 10.6 MJ DE/kg). Water was available continuously from nipple-drinkers. At 11 weeks of age the animals were slaughtered and hind leg (HL) and loin meat (*Longissimus dorsi* muscle /LD/) of 113 rabbits were dissected. LD and *Biceps femoris* (BF) muscles were analysed for ultimate pH (pHu) and L*a*b* colour values (Minolta Chromameter CR-300), whereas HL and LD meat were used for proximate composition (AOAC, 1984) and fatty acid (FA) profile. FA results were expressed as a percentage (w/w) of total FA methyl esters.

The effect of floor type and stocking density on the meat traits were analysed by means of analysis of variance with multiple factors using the following model:

$MT(\%)ij = m + Fi + SDj + eijk$

(MT = meat trait, m= overall mean, Fi = type of floor (i = 1-2), SDj = stocking density (j = 1-3), eijk = random error).
For the statistical evaluation the SAS 9.1.3. statistical software package was used (SAS for Windows, 2003).

III. RESULTS AND DISCUSSION

Compared to wire net floor the combined floor significantly increased the b* colour value of BF muscle (3.15 *vs* 2.66; P<0.01) and the a* colour value of LD muscle (5.10 *vs* 5.04; P<0.05) whereas the pHu of LD decreased (5.70 *vs* 5.72; P<0.05) as well as its fat content (1.04 *vs* 1.18%; P<0.05) (Table 1). Also Jekkel, Milisits, Bàzàr, Locsmàndi, Nagy (2008) reported a trend towards higher a* colour values in LD muscle of rabbits reared on straw litter compared to wire net floor. However, the results found in the present study and that of Jekkel *et al*. (2008) do not lead to a clear evidence of the floor type effect on the meat colour. The pHu trend observed in our study wasn't confirmed by the study of Jekkel *et al*. (2008) as well, suggesting that the pHu was perhaps influenced by the indirect effect of the straw presence, that could have modified the animal behavior (feeding or locomotory). The significantly lower fat content observed in the LD meat of combined floor type animals could be an indication of the above mentioned effect. The three stocking densities applied unaffected the meat quality variables.

Table 1. pHu, L*a*b* colour values, and proximate analysis of rabbit meat

Traits	Floor type		Stocking density (rabbits/m²)			Significance (P)	
	Wire net	Combined	8	12	16	Floor type	Stocking density
Sample N.	59	54	25	37	51		
Biceps femoris muscle (BF):							
pHu	5.67	5.62	5.63	5.67	5.63	0.115	0.352
L*	54.1	54.7	54.1	54.0	55.1	0.247	0.143
a*	7.38	7.15	7.74	7.35	6.70	0.063	0.550
b*	2.66	3.15	2.82	3.80	2.09	0.004	0.255
Longissimus dorsi muscle (LD):							
pHu	5.72	5.70	5.71	5.76	5.66	0.020	0.655
L*	55.6	56.4	56.3	55.6	56.1	0.627	0.146
a*	5.04	5.10	5.44	4.62	5.16	0.031	0.801
b*	4.22	4.27	4.33	3.94	4.47	0.165	0.831
Water, %	73.5	73.7	73.7	73.6	73.5	0.072	0.061
Protein, %	24.1	24.1	24.0	24.0	24.2	0.153	0.956
Fat, %	1.18	1.04	1.05	1.15	1.14	0.018	0.393
Ash, %	1.21	1.19	1.20	1.18	1.23	0.134	0.178
Hind leg (HL) meat:							
Water, %	74.2	74.3	74.4	74.3	74.2	0.221	0.340
Protein, %	22.4	22.5	22.4	22.4	22.5	0.213	0.448
Fat, %	2.01	1.92	1.95	1.91	2.02	0.700	0.460
Ash, %	1.34	1.27	1.21	1.40	1.30	0.171	0.342

Combined floor reduced MUFA (P<0.05) of both HL (24.3 *vs* 24.8 % total FA; P<0.05) and LD meat (27.0 *vs* 27.7 % total FA; P<0.05), and increased PUFA content of LD meat (29.9 *vs* 28.1; P<0.05) (Tables 2 and 3). A similar trend was reported by Dal Bosco *et al.* (2002) on LD meat but not at significant level.

The stocking density effect on the FA profile was moderate and affected only the C17:1 content in both LD (P<0.05) and HL (P<0.01) meats and C18:2c9t11 (CLA) and DHA in LD meat (P<0.01). At the intermediate stocking density of 12 rabbits/m^2, the LD meat showed lower (CLA) (0.175 % total FA) and higher DHA contents (0.098 % total FA) than those found in the meat of the other two extreme stocking densities (on average 0.180 and 0.094% total FA, for CLA and DHA, respectively; P<0.01).

A trend towards a decrease in MUFA and an increase in PUFA in HL meat was observed when decreasing the stocking

density , supporting the findings of Simsek, Cerci, Dalkilic, Yilmaz, Ciftci (2009) in chicken broilers.

Table 2. Fatty acid (FA) profile of the hind leg meat (% total FA)

Traits	Floor type		Stocking density (rabbits/m²)			Significance (P)	
	Wire net	Combined	8	12	16	Floor type	Stocking density
Sample N.	59	54	25	37	51		
C6:0	0.354	0.237	0.291	0.346	0.251	0.631	0.187
C10:0	0.251	0.247	0.245	0.253	0.249	0.590	0.405
C12:0	0.161	0.157	0.151	0.157	0.168	0.117	0.501
C14:0	1.62	1.55	1.56[a]	1.55[a]	1.64[b]	0.033	0.033
C15:0	1.48	1.47	1.47	1.46	1.48	0.937	0.813
C16:0	22.4	22.1	22.0	22.4	22.5	0.343	0.256
C17:0	0.549	0.546	0.552	0.545	0.545	0.987	0.935
C18:0	7.09	7.14	7.23	7.17	6.94	0.061	0.628
C20:0	0.123	0.120	0.121	0.124	0.120	0.423	0.362
Total SFA	34.9	35.0	34.4	34.8	35.6	0.497	0.870
C14:1	0.044	0.042	0.041	0.052	0.035	0.136	0.818
C16:1	2.20	1.97	1.96[a]	1.99[a]	2.30[b]	0.010	0.029
C17:1	0.222	0.219	0.219[a]	0.216[a]	0.228[b]	0.310	0.001
C18:1n-9	19.3	18.9	18.9	19.1	19.3	0.280	0.057
C18:1n-7	1.74	1.72	1.70	1.74	1.75	0.644	0.591
C20:1n-9	0.223	0.215	0.215	0.227	0.215	0.274	0.205
Total MUFA	24.8	24.3	24.0	24.4	25.3	0.035	0.231
C18:2n-6	27.3	27.9	28.6	27.8	26.3	0.006	0.316
C18:2c9t11	0.142	0.138	0.140	0.132	0.143	0.007	0.397
C18:3n-6	0.084	0.086	0.084	0.086	0.084	0.716	0.401
C18:3n-3	1.96	1.90	1.98	1.95	1.86	0.494	0.530
C20:2n-6	0.301	0.298	0.306	0.301	0.292	0.073	0.581
C20:3n-6	0.404	0.428	0.432[b]	0.422[b]	0.393[a]	0.011	0.035
C20:4n-6	3.83	4.05	4.14	4.02	3.73	0.012	0.124
EPA	0.132	0.134	0.134	0.132	0.132	0.935	0.697
C22:5n-3	0.588	0.617	0.607	0.613	0.587	0.391	0.690
DHA	0.126	0.128	0.128	0.129	0.124	0.004	0.142
Total PUFA	38.1	39.1	39.3	38.5	38.0	0.191	0.084
n-6	32.5	33.7	33.5	33.0	32.7	0.111	0.767
n-3	3.08	3.12	3.18	3.12	3.00	0.074	0.593
n-6/n-3	10.9	11.2	11.1	11.0	11.2	0.783	0.106

a, b: $P<0.05$

As regards the FA profile from the dietetic point of view, the rabbit meat wasn't affected neither by the floor type, nor by the stocking density effects, being similar the total n-3 FA and the n-6/n-3 ratio on both HL and LD meat portions. The latter ratio was favourably lower in HL (11.0) than in LD meat (12.8), contradicting the trend found in literature for these two rabbit meat portions.

Table 3. FA profile of the LD meat (% total FA) (a, b: P<0.05)

Traits	Floor type		Stocking density (rabbits/m²)			Significance (P)	
	Wire net	Combined	8	12	16	Floor type	Stocking density
C6:0	0.724	0.746	0.788	0.714	0.702	0.857	0.833
C10:0	0.145	0.144	0.137	0.154	0.143	0.138	0.139
C12:0	0.153	0.148	0.143	0.163	0.147	0.562	0.103
C14:0	1.98	1.89	1.91	1.95	1.96	0.097	0.729
C15:0	1.17	1.21	1.20	1.15	1.22	0.519	0.553
C16:0	29.6	29.0	29.3	29.4	29.3	0.098	0.977
C17:0	0.606	0.609	0.614	0.601	0.607	0.952	0.977
C18:0	8.59	8.75	8.75	8.72	8.54	0.145	0.202
C20:0	0.128	0.131	0.128	0.131	0.129	0.272	0.606
C21:0	0.062	0.068	0.077^{b}	0.055^{a}	0.064^{ab}	0.342	0.045
Total SFA	38.5	38.3	39.9	36.8	38.5	0.860	0.114
C14:1	0.078	0.073	0.078	0.072	0.076	0.169	0.480
C16:1	1.78	1.68	1.60	1.75	1.84	0.349	0.137
C17:1	0.263	0.259	0.261^{ab}	0.258^{a}	0.263^{b}	0.007	0.017
C18:1n-9	21.8	21.4	21.4	21.6	21.8	0.116	0.523
C18:1n-7	1.68	1.70	1.71	1.67	1.70	0.639	0.645
C20:1n-9	0.251	0.260	0.261	0.252	0.252	0.224	0.523
Total MUFA	27.7	27.0	27.2	27.3	27.4	0.044	0.838
C18:2n-6	24.1	25.3	23.9	25.6	24.5	0.241	0.422
C18:2c9t11	0.180	0.177	0.179^{b}	0.175^{a}	0.180^{b}	0.025	0.003
C18:3n-6	0.076	0.077	0.073	0.078	0.079	0.512	0.085
C18:3n-3	1.67	1.84	1.59	1.93	1.75	0.246	0.211
C18:4n-3	0.267	0.259	0.267	0.252	0.271	0.253	0.055
C20:2n-6	0.350	0.354	0.359	0.349	0.347	0.471	0.286
C20:3n-6	0.249	0.251	0.265	0.248	0.238	0.890	0.167
C20:3n-3	0.096	0.103	0.106	0.096	0.096	0.063	0.053
C20:4n-6	2.35	2.55	2.51	2.49	2.35	0.076	0.355
EPA	0.103	0.106	0.103	0.109	0.102	0.525	0.175
C22:5n-3	0.329	0.339	0.352	0.321	0.329	0.637	0.492
DHA	0.094	0.097	0.095^{a}	0.098^{b}	0.093^{a}	0.010	0.002
Total PUFA	28.1	29.9	29.2	28.9	29.0	0.036	0.949
n-6	26.7	28.0	27.8	26.9	27.2	0.057	0.597
n-3	1.75	1.84	1.74	1.85	1.79	0.208	0.456
n-6/n-3	12.7	12.8	12.9	12.7	12.6	0.594	0.580

IV. CONCLUSION

On the basis of the results, it can be concluded that the floor type and the stocking density effects were moderate on the physical traits and on the FA profile of the rabbit meat. The proximate composition of the rabbit meat was unaffected by the three stocking densities, whereas the meat fat content decreased when rabbits were reared on the combined floor, provided with straw litter.

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