A COMPARISON OF THE CARCASS AND MEAT QUALITY OF ISA (F15) SPENT HENS AT TWO DIFFERENT AGES

K. Hafid[1], M.Gagaoua[1], H.-R. Boudechicha[1], S. Becila[1] and A. Boudjellal[1]

[1] Equipe Maquav, INATAA, Université des Frères Mentouri Constantine 1, Route de Ain El-Bey, 25000 Constantine, Algeria

Abstract– Total of 16 spent hens (ISA F15) were slaughtered at about 220 and 337 days of age (8 animals per age). Tenderness was estimated from breast muscle using Penetrometer PNR 10 and sensory trained panel. Water holding capacity, percentage of released water, cooking loss, pH and myofibril fragmentation index were also estimated. The result revealed that penetration values were found negatively correlated with tenderness and Myofibril fragmentation index (r= -0.54 and r= -0.59 respectively). Moreover, tenderness score was negatively correlated with animal age. pH was positively related with tenderness. Acceptability of spent hens meat was higher irrespective of age.

Key Words – spent hens, meat, penetrometer, sensory analysis, age.

I. INTRODUCTION

In Algeria, there is an intense expansion of eggs production leading to abundant availability of spent hens. Also, since the beginning of the 1980's, the Algerian ministry of agricultural oriented consumer's meat consumption to white meat as an alternative to beef and lamb for numerous economical and health reasons. Poultry is well known to contain low cholesterol and fat with very high omega-3 fatty acids contents [1]. Also, meat from spent hen is described as a good protein source. Nevertheless, much remain to be done to increase the value of spent hen meat in Algeria, which is perceived as very tough by consumers. Moreover, there is little information on muscle characteristics and meat quality of ISA (F15) spent hen, the largest produced poultry in the country. The aim of this study was first a characterization of muscle and meat quality of spent hens and second, investigation of the potential of penetrometer to predict meat tenderness. This approach can be very useful to choose the final destination of the carcasses toward direct consumption or transformation. This is also an open research window to increase our knowledge on spent hen ISA (F15) muscle to propose alternatives for the Algerian poultry industries.

II. MATERIALS AND METHODS

Two groups of 16 spent hens (F15) obtained from INAP Constantine (Algeria) were slaughtered at about 337 (batch 1) and 220 (batch 2) days of age (8 animals by group). They were slaughtered in compliance to Halal slaughter method in accordance with the Islamic legislation. Carcasses were then chilled at 4°C for 14h, before sampling of the pectoral muscles (breast muscles) for i) textural, ii) sensory analyses and iii) biochemical traits measurements. For instrumental texture, the Petrotest PNR 10 penetrometer was used [2]. For that, ten parallelepipedic samples ($4 \times 2 \times 1.5$ cm) were dissected from m. superficial pectoral of each animal. The instrument device is provided with a discerning body (2.5 g) which penetrates in free fall (perpendicularly to the muscular fibers) the sample under its own weight, during approximately 5s. The depth of penetration was measured in mm or unit of penetration (1 UP = 0.1 mm).

After textural measurements, the same samples were cooked in a bath water until reaching an internal end-point temperature of 75°C [3]. Just after cooking, the samples were immediately served to the panellists (10 persons) to evaluate on a unstructured scale (0 to 10) [4]: tenderness, juiciness, cohesiveness, chewiness, residues and overall liking in which a score of 0 means tough, not juicy, not cohesive, not chewy, nothing and dislike, and score of 10 means tender, extremely juicy, very cohesive, very chewy, extreme and like too much, respectively. The panellists were seated in individual boxes with a drinking cup containing water (90%) and apple juice (10%) to cleanse the palate between tastes [5].

The pH in triplicate was determined using sodium iodoacetate (5 mM) and potassium chloride (150 mM) according to McGeehin et al. [6]. Water holding capacity (WHC) was determined

according to the Grau-Hamm method [7, 8] with slight modifications concerning the areas determination. Traditionally, the areas of meat spot (M) and released juice (T) were measured using a Planimeter, but the method is not very precise and instrument dependent. To do it, we developed in this study a simple technique using image analysis. For that, the areas were measured using the open source ImageJ 1.48 software. The areas drawn in clear plastic were scanned and quantified using freehand selection option. For cooking loss, 10g of each weighed (P_1) muscle (in duplicate) were vacuum packed and frozen at -20°C until use. When required, the samples were thawed at 4°C for 24h and cooked in plastic bags at 80°C for 1h by immersion in a water bath. After cooling, samples were removed from the bags and weighed (P_2). Cooking losses were calculated as (P_1- P_2) ×100/P_1 [9].

Myofibril fragmentation index (MFI) was determined using the procedure of Li *et al.* [10]. Determination of protein concentration was done by the Bradford method [11]. Dilutions were done to obtain 0.5 (±0.05) mg/mL of protein concentration. MFI is the value of absorbance of the myofibrillar suspension, measured at 540 nm multiplied by 200.

Statistical analyses were conducted using all the spent hens XlStat (Version 2009.1.01, Addinsoft ®). The software was used to conduct variance, principal component (PCA) and Pearson correlations analyses.

III. RESULTS AND DISCUSSION

Means and standard deviations of the mechanical, biochemical and palatability traits of m. superficial pectoral of the two hens' batches are displayed in Table 1. The two batches were highly different in their age but without difference in their body weight. They were very different in terms of pH, percentage of released water (PRW), cooking loss (CL), tenderness and residues scores. The batch 1 (old spent hens) had significant lower pH, PRW%, CL% and tenderness scores. Residues scores were significantly different and are as expected the highest within the old spent hens (batch 1).

We can speculate that the oldest the spent hens are,

Table 1. Variance analysis and LSMeans (± SD) of mechanical, biochemical and palatability traits of superficial pectoral muscle of the two spent hens batches.

the lowest are pH, PRW, CL and tenderness and the highest are residuals scores. Otherwise, there is no significant difference in penetration depth

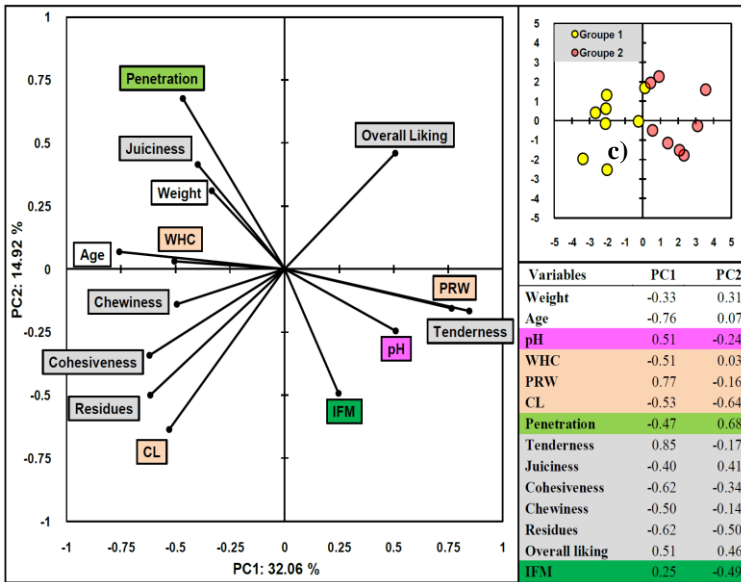| Variables	Spent hens batches		SEM	P-value
	1	2		
Age (days)	337 ± 16.24	220 ± 1.00	15.41	***
Weight (kg)	1.79 ± 0.18	1.78 ± 0.29	0.06	Ns
pH	5.76 ± 0.25	6.24 ± 0.27	0.09	**
WHC	32.72 ± 3.54	29.63 ± 3.48	0.99	Ns
PRW	34.09 ± 2.80	39.31 ± 2.94	1.00	**
CL	33.38 ± 1.40	31.14 ± 2.24	0.56	*
Penetration	6.83 ± 0.54	6.58 ± 0.55	0.14	Ns
Tenderness	6.16 ± 1.11	7.42 ± 0.47	0.27	*
Juiciness	4.01 ± 1.31	3.10 ± 0.70	0.30	Ns
Cohesivness	5.05 ± 1.55	3.76 ± 1.25	0.40	Ns
Chewiness	5.15 ± 1.38	4.27 ± 0.93	0.32	Ns
Residues	4.35 ± 1.09	3.13 ± 0.70	0.28	*
Overall liking	5.69 ± 1.03	6.30 ± 0.81	0.25	Ns
MFI	22.20 ± 3.39	23.25 ± 4.86	1.09	Ns

Significance: * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$; Ns: not significant. Abbreviations: WHC: water holding capacity, PRW: percentage of released water, CL: cooking loss, MFI: myofibril fragmentation index.

between the two batches. The other textural sensory attributes, likely juiciness, cohesiveness, chewiness were also not different ($P < 0.05$). The panellists scored the two poultry batches very high for the hedonic attribute, overall liking. It seems clearly that the meat of spent hens is judged acceptable by the panellists irrespective of age.

The Pearson correlation coefficients between the studied traits are shown in Table 2. As expected, the sensory characteristics had close and significant correlations with each other ($P < 0.05$) and most are above 0.5. Accordingly, numerous studies reported close relationships between sensory traits [12]. As expected, tenderness was negatively correlated with penetration depth values (r = -0.54). These findings are in line to those reported in earlier studies from Gregory et *al.* [13], Crouse et *al.* [14] and Caine et *al.* [15]. These authors reported high negative correlations between sensory measures of tenderness and Warner-Bratzler shear force (WBSF) values (-0.55, -0.58 and -0.60 respectively). Other studies reported very close relationships (0.65 < r < 0.85) between sensory toughness and WBSF [16- 17]. It is worth mentioning that other studies failed to found any relationships.

Fig. 1. Principal component (PC) analysis. **a)** Projection of the studied variables in the two first components (47%). **b)** Bi-plot of the animal observations corresponding to batch 1 (old spent hens in yellow) and

a) b)

c)

Variables	PC1	PC2
Weight	-0.33	0.31
Age	-0.76	0.07
pH	0.51	-0.24
WHC	-0.51	0.03
PRW	0.77	-0.16
CL	-0.53	-0.64
Penetration	-0.47	0.68
Tenderness	0.85	-0.17
Juiciness	-0.40	0.41
Cohesiveness	-0.62	-0.34
Chewiness	-0.50	-0.14
Residues	-0.62	-0.50
Overall liking	0.51	0.46
IFM	0.25	-0.49

2 (young spent hens in pink). (c) Coefficients in the eigenvectors (loadings) for the first two PC.

Bouton et al. [18] suggested that the lack of closer relationships between objective and subjective measures of tenderness could be explained by sampling variation and the fact that stress and strain patterns developed in the mouth, during chewing and mastication of meat are not adequately represented by instrumental techniques. Moreover, penetration values in this study were negatively related to myofibrillar fragmentation index (MFI) values. This result is in agreement to those reported earlier [19-20]. In this study, penetration had significant positive correlation with juiciness. In contrast, Caine et al. [15] found no significant correlation between juiciness and Texture Profile Analysis (TPA) or WBSF. On another hand and as expected, tenderness scores were negatively correlated with animal age together with ultimate pH, that is in accordance with earlier findings reported by [21, 22, 23]. Furthermore, Age had a significant effect on cooking loss which confirms the result of Northcutt et al. [23] and many other studies.

The results of the PC analysis are shown in Fig. 1. The two first PCs explained 47% of variability (Fig. 1a). Two distinctive groups according to slaughter age of the spent hens are obtained and presented in the bi-plot (Fig. 1b). The young spent hens are grouped in the right side and the aged

Table 2. Significant Pearson correlation coefficients (*P* < 0.05) obtained between the studied variables for all spent hens considered as one data set using Z-scores.

Variables	Wt	Age	PRW	Pe	Te	Co	Re
pH		-0.69					
WHC	0.51		-0.61		-0.25		
PRW		-0.67					
CL							0.56
Te		-0.63	0.52	-0.54			
Ju				0.58			
Co					-0.51		
OL					0.50	-0.58	
MFI				-0.59			

Abbreviations: Wt: weight; WHC: water holding capacity; PRW: percentage of released water; CL: cooking loss; Te: tenderness; Ju: juiciness; Co: cohesiveness; OL: overall liking; MFI: myofibril fragmentation index.

ones are in the left side. The first PC explaining 32% of variability was mainly characterized by PRW, tenderness, overall liking and pH on the positive side and textural attributes (cohesiveness, chewiness and residues) representing the undesirable properties and age on the negative side. The second PC explaining 15% of variability was mainly characterized by penetration on the positive side and CL, residues scores and IFM on the negative side.

We failed in this study to found significant relationship between pH and water holding capacity (r = -0.41, *P* < 0.1) and pH and tenderness (r < 0.36). Musa et al. [24] reported positive relationship between pH and tenderness which is in the same direction within this study.

IV. CONCLUSION

There were differences between the two poultry badges in terms of water activity (PRW and CL) and tenderness. The study revealed that age at slaughter had a significant effect on tenderness without effect on meat acceptability by the panellists. Penetrometery seems to have a great potential of being an excellent predictor of meat tenderness. We can speculate that the old spent hens can be used for direct human consumption if required but we should provide the effect of ageing time on its structural properties to improve its textural scores. Although a number of significant correlations were observed between penetration measurements and tenderness scores and MFI.

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