EFFECT OF INCLUSION IN DIET OF POTATO WASTE AND TRITICALE PEA SILAGE IN MEAT QUALITY OF CALVES

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Abstract – The effect of finishing diet on meat quality attributes of crosses calves was evaluated. Twelve *longissimus dorsi* samples from three different diets: control (CO), waste potatoes (PO) and triticale pea silage (TP) were analyzed. Regarding chemical composition, several parameters showed significant differences among groups. The water percentage was higher in samples from TP group (74.66%), while protein content was higher in samples from PO treatment (23.89%). Concerning color parameters, meat samples from CO batch presented lower values of redness (12.09) and yellowness (12.84) than samples from PO (14.95 and 14.08, respectively) and TP (14.33 and 13.11, respectively). Finally, the most abundant fatty acid, within monounsaturated acids, was the C18:1n9c (CO: 27.46% *vs*. PO: 28.16% *vs*. TP: 29.76%), while within the saturated family this position was occupied by the C16:0 (CO: 23.82% vs. PO: 24.51% vs. TP: 23.35%)

Keywords – beef, feeding, physicochemical composition, fatty acid profile

I. INTRODUCTION

The livestock sector is the major economic activity in the Autonomous Community of Galicia, located in Northwest Spain [1], where the calves are the most characteristic expression of regional livestock production. Those animals are usually fed grass during the summer months and conserved silage forage in the winter. A good feeding calves strategy could improve meat quality and increases in the sold price [2].

Beef cattle producers always are trying to reduce the feeding cost to increase the farm profit; hence they are seeking for alternative feedstuffs. In agriculture there are food products of high quality which were intended for human consumption but which are rejected at the factory by visual defects. Obviously, these products can be use in animal feeding and one option worth considering is waste potatoes. As a comparative purpose in this study we use triticale pea silage for calve feed and a control group based on commercial feeding.

The aim of this work was to study how feeding type affected on the main attributes of quality, such as physicochemical composition, textural properties and fatty acids of calves.

II. MATERIALS AND METHODS

II.1. Experimental design and sampling

For this study, twelve calves per group obtained from Coren (Ourense, Spain) were used. These animals were finishing three month previous to slaughter with commercial feeding and straw (CO; 90% commercial feeding, 10% straw) as base feed and replacement in part with waste potato (PO; 74% commercial feeding, 18% waste potato and 8% straw) and triticale pea silage (TP; 90% commercial feeding, 10% triticale pea silage). Animals were slaughtered at 15 months old at a commercial abattoir (NovaFrigsa, Lugo). Immediately after slaughter, carcasses were weighted and chilled at 4 ºC in a cold chamber for 24 hours. At this point, the *longissimus dorsi* (LD) muscle was extracted from the left half of each carcass, between the fifth and the tenth rib. Samples were packed under vacuum conditions and stored under frozen conditions. The samples were thawed under refrigeration conditions (4 ºC) 24 hours before analysis.

II.2. Analytical methods

In the LD muscle it took place the following physicochemical measures to assess the meat quality: pH, colour, chemical composition, water holding capacity and texture analysis. The pH of samples was measured directly using a pH-meter (HI 99163, Hanna Instruments, Spain) equipped with a glass probe for penetration. Instrumental colour in the CIELAB space (lightness: L*, redness: a* and yellowness: b*) [3] was automatically measured on the surface of samples by a CM-600d portable colorimeter (Konica Minolta Sensing, Japan). Moisture, intramuscular fat (IMF), protein and ash were quantified according to the ISO recommended standards 1442:1997 [4], 1443:1973 [5], 937:1978 [6] and 936:1998 [7], respectively. The water holding capacity (WHC) was measured in three ways: cooking loss (CL), pressing loss (PL) and drip loss (DL), which were evaluated according to Hönikel [8]. To measure properties of texture, the meat was cooked in a water bath at 80 ºC by immersion until the temperature reached 70 ºC *in quore*. The temperature control was carried out using type K thermocouples connected to a data logger (N3000, UK). Warner-Braztler (WB) test and texture profile analysis (TPA) were carried out according to the conditions described by Franco *et al.* [9]. A texture analyzer (TA.XT.plus Stable Micro Systems, UK) was used for both test, and all samples were cut or compressed perpendicular to the muscle fibre direction at a crosshead speed of 3.33 mm/s. The average value for each LD sample was recorded from four replicates.

II.3. Analysis of fatty acids

The fat extraction for the determination of fatty acid composition was performance following the method proposed by Folch *et al.* [10]. The fatty acid methyl esters formation was carried out using the acid transesterification method described by Carreau and Dubacq [11]. The identification and quantification took place using gas chromatography following the chromatographic conditions described by Lorenzo *et al.* [12].

II.4. Statistical analysis

Results were statistically analyzed using the SPSS package (SPSS 18.0, USA). One-way analysis of variance (ANOVA) and a posterior Duncan´s test with a *P*<0.05 level of significance were performed.

III. RESULTS AND DISCUSSION

III.1. Meat quality

Mean values of physicochemical parameters are shown in Table 1.

Table 1. Characteristics of the calves meat quality for each finishing group

	CO	PO	TP	SEM	SIG
Chemical composition					
pH	5.64	5.63	5.59	0.03	n.s.
Water (%)	74.35^{a}	73.00^{b}	74.66^{a}	0.22	***
Intramuscular fat (%)	1.46	1.83	1.16	0.15	n.s.
Protein (%)	23.06^{b}	23.89^{a}	22.79^{b}	0.12	**
Ashes (%)	1.28^{a}	1.22^{b}	1.22^{b}	0.01	*
Color parameters					
Luminosity (L*)	41.03	39.97	39.05	0.39	n.s.
Index of red (a*)	12.09^{b}	14.95^{a}	14.33^{a}	0.32	***
Index of yellow (b*)	12.84^{b}	14.08^{a}	13.11^{b}	0.25	**
WHC (%)					
Cooking losses (%)	25.07^{b}	29.76^{a}	25.27^{b}	0.54	**
Pressing losses (%)	21.27^{a}	18.27^{b}	23.64^{a}	0.63	***
Drip losses (%)	2.88^{a}	2.43^{b}	2.94^{a}	0.10	*
Textural parameters					
Firmness (Kg/s)	1.04	0.97	1.02	0.05	n.s.
Total work (Kg·mm)	19.6	17.35	18.3	0.91	n.s.
Shear force (Kg/cm^2)	4.3	3.6	3.85	0.20	n.s.
Hardness (Kg)	5.60	5.35	6.51	0.20	n.s.
Springiness (mm)	0.48	0.49	0.47	0.01	n.s.
Cohesiveness	0.55^{a}	0.55^{a}	0.53^{b}	0.00	*
Gumminess (Kg)	3.05	2.98	3.45	0.11	n.s.
Chewiness (kg·mm)	1.51	1.47	1.62	0.06	n.s.

Significance: *** (P<0.001); ** (P<0.01); * (P<0.05); n.s. (not significant). SEM: standard error of the mean.

In the three groups, the pH values ranged within an acceptable range [13] between 5.59 and 5.64. Similar values were found by other authors in Rubia Gallega calves [14]. Concerning chemical composition, significant differences were found among groups in relation to water (*P*<0.001), protein (*P*<0.01) and ashes (*P*<0.05) contents. Moisture values were higher in CO (74.35%) and TP (74.66%) than in PO (73.00%) groups. The protein values were higher in PO (23.89%) than in CO (23.06%) and TP (22.79%) groups, whereas the highest ashes content was noticed in CO treatment (1.28%). On the contrary, no significant differences (*P*>0.05) were found among groups in relation to IMF. Protein and IMF percentages of the present study were higher than those obtained by other authors [15] in Galician exploitation, due to differences in genotype and reared conditions. With regard to colorimetric characteristics, redness (a*) and yellowness (b*) indexes were significantly (*P*<0.01) affected by the type of finishing feed. The a* and b* values ranged between 14.95 to 12.09, and 14.08 to 12.84, respectively corresponding to PO and CO groups in both cases. In general, our a* and b* values were higher than those reported by other authors [14,16]. The WHC has a great impact in the final properties of the meat, because affects the consumer acceptance [17] in terms of juiciness, especially in raw meat with a low IMF content. Indeed, the juiciness is affected by WHC, due to the water losses that occur during cooking [17].

The mean values obtained for CL (*P*<0.01), PL (*P*<0.001) and DL (*P*<0.05) displayed significant differences among three groups with mean values of 29.76%, 25.27% and 25.07% for PO, TP and CO groups, respectively. However, WHC measured as PL and DL showed the highest values in TP group with values of 23.64% and 2.94%, respectively. Our results for CL were lower than those found by other authors [14,16] with values above the 30%.

The textural parameters obtained with WB test showed no significant differences among feeding groups while, in TPA test, only cohesiveness displayed significant (*P*<0.05) differences. Hardness values were in the range between 6.51 kg (TP) and 5.35 kg (PO) and they were lower than those reported by other authors [16].

III.3. Fatty acid composition

The fatty acid composition of LD muscle is shown in Table 2.

Table 2 Fatty acid composition (%) of Longissimus dorsi muscle from calves

	CO	**PO**	**TP**	**SEM**	**SIG**
C10:0	0.03^{a}	0.032^{a}	0.02^{b}	0.001	**
C12:0	0.11^{a}	0.10^{a}	0.07^{b}	0.004	***
C13:0	0.53^{ab}	0.45^{b}	0.65^{a}	0.03	*
C14:0	2.78^{b}	2.99^{a}	2.27^{b}	0.11	*
C14:1n5	0.81	0.86	0.90	0.02	n.s.
C15:0	0.38^{a}	0.43^{a}	0.27^{b}	0.01	***
C15:1n5	0.02	0.02	0.02	0.001	n.s.
C16:0	23.82	24.51	23.35	0.35	n.s.
C16:1n7	2.60	2.84	2.54	0.09	n.s.
C17.0	1.04^{a}	1.13^{a}	0.77^{b}	0.03	***
C17:1n7	0.66^{a}	0.70^{a}	0.51^{b}	0.02	**
C18.0	15.19^{b}	15.29^{b}	17.01^{a}	0.31	*
C18:1n9t	0.26^{b}	0.39^{a}	0.23^{b}	0.01	***
C18:1n1t	5.89^{a}	4.87^{a}	2.89^{b}	0.37	**
C18:1n9c	27.46	28.16	29.76	0.58	n.s.
C18:1n7c	1.79^{a}	1.82^{a}	1.52^{b}	0.04	**
C18.2n6c	11.91	11.00	12.27	0.66	n.s.
C20:0	0.10	0.09	0.11	0.003	n.s.
C18:3n6	0.06	0.05	0.05	0.003	n.s.
C20:1n9	0.15	0.13	0.15	0.004	n.s.
C18:3n3	0.46	0.29	0.45	0.03	n.s.
C18:2n7CLA	0.19^{b}	0.16^{b}	0.26^{a}	0.009	***
C21:0	0.03^{ab}	0.04^{a}	0.02^{b}	0.002	*
C20:2n6	0.10	0.09	0.09	0.003	n.s.
C22:0	0.02	0.01	0.02	0.002	n.s.
C20:3n6	0.53	0.53	0.53	0.03	n.s.
C20:3n3	0.007^{b}	0.01^{a}	0.009^{b}	0.001	*
C20:4n6	2.38	2.41	2.38	0.15	n.s.
C23:0	0.01	0.01	0.01	0.001	n.s.
C20:5n3	0.12^{b}	0.07^{b}	0.20^{a}	0.01	**
C24:0	0.01	0.01	0.01	0.001	n.s.
C20:5n3	0.32^{ab}	0.26^{b}	0.42^{a}	0.02	*
C22:6n3	0.05	0.05	0.07	0.008	n.s.
∑SFA	44.10	45.17	44.63	0.44	n.s.
∑MUFA	39.66	39.81	38.55	0.60	n.s.
∑PUFA	16.19	14.98	16.78	0.87	n.s.
PUFA/SFA	0.41	0.38	0.45	0.03	n.s.
∑n6	15.03	14.12	15.35	0.82	n.s.
∑n3	0.98^{ab}	0.69^{b}	1.16^{a}	0.06	*
n6/n3	15.65^{b}	20.24^{a}	13.54^{c}	0.64	***

Significance: *** (P<0.001); ** (P<0.01); * (P<0.05); n.s. (not significant). SEM: standard error of the mean.

SFA=Saturated fatty acids, MUFA=Monounsaturated fatty acids, PUFA=Polyunsaturated fatty acids.

The predominant fatty acids were the saturated fatty acids (SFA), with values that ranged between 45.17% (PO batch) and 44.10% (CO group) followed by monounsaturated fatty acids (MUFA), with values between 39.81% (PO treatment) and 38.55% (TP batch), and polyunsaturated fatty acids (PUFA), with values between 16.78% (TP group) and 14.98% (PO treatment). Within SFA, C16:0 and C18:0 were the majority fatty acids in the IMF profile. The C16:0 showed the highest values in the PO group, while C18:0 was the highest in TP batch. The percentages found for SFA were lower than those reported by other authors [14].

IV. CONCLUSION

The results obtained confirm that the feeding supplemented whit potatoes and triticale pea silage could be interesting to complement the commercial feeding. Thus this inclusion could allow the farmers to reduce insumes cost related to finishing feeding of calves, without significant modification of meat quality.

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