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Technical note

Sensory quality of meat from suckling kids of two indigenous Spanish goat breeds raised in grazing production systems

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Abstract:

In Spain, there is growing interest in the conservation of native goat breeds in grazing production systems, and the possibility of conventional farms transitioning to organic. This requires a complete understanding of the repercussions of this transition, including its effect on end product sensory quality. An evaluation was done of the sensory attributes of suckling goat meat from two indigenous Spanish breeds (Payoya and Blanca Andaluza) raised in conventional and organic grazing production systems. Of

the 21 suckling kids used, 12 were raised in an organic system (6 Payoya and 6 Blanca Andaluza) and 9 in a conventional system (3 Payoya and 6 Blanca Andaluza). Meat sensory profile was evaluated by an analytical panel. The meat from kids raised in organic systems had less intensity of smell and a softer, more tender and juicier texture than meat from the conventional systems. Meat from Blanca Andaluza kids exhibited lower odor intensity and a softer, more tender and juicier texture than the Payoya kid meat. These are promising preliminary results that highlight some of the benefits resulting from the transition from conventional to organic grazing systems for goat production.

Key words: Sensory quality, Kid meat, Ecological.

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There is growing interest in Spain, both in government and among producers, in the conservation of indigenous livestock breeds raised in extensive or semi-extensive grazing systems. Many of these breeds, such as the Blanca Andaluza and Payoya goat breeds, are considered to be endangered[1]. Both are largely produced on farms in remote mountainous areas in the Andalusia Autonomous Community (Comunidad Autónoma de Andalucía)[2].

The Blanca Andaluza breed is raised for meat production. In areas where it is traditionally eaten kids are still raised with the mother in a grazing system and then slaughtered at five months of age at about 25to 30 kg live weight. However, commercial production is mostly of suckling kid[2]. The Payoya breed is representative of grazing-based dairy-producing goat breeds in the region. Farms raising this breed focus mainly on dairy production with suckling kid meat as an appealing secondary product due to its high market price. In this system kids are slaughtered at 8 to 9 kg live weight.

Farms commercially producing these two goat breeds can easily be transformed into organic farms[3,4]. Determining the feasibility of this transformation requires analyses of technical and economic viability, as well as study of product quality. Our research group has produced two studies on the fatty acid profile[5,6] and two on meat quality in these breeds[7,8], using animals from the same farms as those used in the present study. No significant differences were observed between kids raised in conventional and organic farms in terms of most fatty acids in intramuscular fat or other fatty deposits, and meat attributes. These findings suggest that, from a product quality perspective, there is no impediment to making the transformation. It seems that no previous research

has been published on the sensory quality of meat from the Blanca Andaluza and Payoya breeds. Based on previous studies it is improbable that the sensory quality of suckling kid meat from these breeds exhibits notable differences between conventional and organic production systems. If this is the case, the transformation of conventional farms to the organic system would become that much more appealing. The present study objective was to quantify the sensory quality of suckling kid meat from the Payoya and Blanca Andaluza breeds raised in grazing-based organic and conventional production systems.

The evaluated meat was sourced from suckling kids raised on four semi-extensive goat farms (two conventional and two organic)[5,6]. Both types of farm were certified according to the regulations of the European Council (EC) (No. 834/2007)[9], and the guidelines for each breed (Payoya and Blanca Andaluza). Diets for the goats on all four farms were based on grazing of natural Mediterranean shrub-type grasses. The study area is dominated by shrubs (60 to 80% coverage, approximately 0.6 to 1.8 m height) and trees (mainly *Mirtus communis*, *Pistacia lentiscus*, *Quercus ilex*, *Cistus salvifolius* and *Arbutus unedo*). There are also grasses (*Lolium* spp., *Phalaris aquatica*, *Hainardia cylindrica*, *Hordeum bulbosum*), legumes (*Trifolium subterraneum*, *T. pallidum*, *T. aquamosum*, *T. squarrosum*, *T. istmocarpum*, *Scorpiurus muricatus*, *S. vermiculatus*, among others) and other dicotyledons (*Cichorium* spp., *Carlina racemosa*, *Cynara humilis*, *Echium plantagineum*, *Galactites tomentosa*, *Scolymus* spp., among others). At all four farms the goats were grazed daily, regardless of grass availability, and penned at night to allow the kids to nurse. Feed concentrate supplements were provided in all cases. For the Payoya breed these were used at 1 kg/head/day in the conventional farms and 0.5 kg/head/day in the organic farms. For the Blanca Andaluza breed they were used at 0.6 kg/head/day in the conventional farms and 0.35 kg/head/day in the organic farms (Table 1).

Table 1: Concentrate supplement ingredients and chemical composition in conventional and organic goat production systems

Ingredients (% fresh matter)	Payoya		Blanca Andaluza	
	Conventional	Organic	Conventional	Organic
Barley grain	10.0	74.0	-	74.0
Fava bean	-	-	60.0	-
Beet pulp	9.5	-	-	-
Carob	-	4.0	-	4.0
By-pass fat	1.5	-	-	-
Gluten feed	12.0	-	-	-
Peas	-	5.0	40.0	5.0
Maiz kernals	26.0	-	-	-
Soy meal	18.2	-	-	-
Cane sugar molasses	2.0	-	-	-
Sunflower seed meal	5.0	-	-	-
Sunflower seeds	-	5.0	-	5.0
Wheat bran	-	4.0	-	4.0
Wheat flour	12.0	-	-	-
Wheat husk	-	5.0	-	5.0
Calcium carbonate	1.8	2.5	-	2.5
Manganese oxide	0.2	-	-	-
Sodium bicarbonate	0.8	-	-	-
Salt	0.8	0.5	-	0.5
Vitamin-mineral corrector	0.2	-	free	-
Chemical composition (% dry matter):				
Dry matter (%)	92	93	88	93
Organic matter	93	94	97	94
Crude protein	21	19	22	19
Crude fat	2	2	1	2

Animals of both breeds grazed year round. Supplements: Payoya, 1 kg/head/day on conventional farms and 0.5 kg/head/day on organic farms; Blanca Andaluza, 0.6 kg/head/day on conventional farms and 0.35 kg/head/day on organic farms.

Experimental animals were 21 suckling kids, born of double births. Of these, twelve were raised using an organic system (6 Payoya, 6 Blanca Andaluza), and nine using a conventional system (3 Payoya, 6 Blanca Andaluza). Mother/kid pairs were randomly selected at each farm within the same season. The kids had access to their mothers throughout the lactation period, but not to other foods.

All kids were slaughtered at a live weight of 8.12 ± 0.49 kg (Payoya) or 7.52 ± 0.64 kg (Blanca Andaluza) in a government slaughterhouse in Huelva, Spain. They were killed after fasting for 16.00 ± 0.75 h (Payoya) or 19.81 ± 2.49 h (Blanca Andaluza) with free access to water. After slaughter, the carcasses were refrigerated at 4 °C and cured for 24

h. The left half of each carcass was transported under refrigeration to the University of Huelva. The half carcasses were butchered and the legs separated[10], and all cuts vacuum packed and frozen at -20 ºC until analysis. Mean leg weight was 0.65 ± 0.03 kg in the Payoya kids and 0.56 ± 0.07 kg in the Blanca Andaluza kids.

Prior to sensory analysis, the legs were thawed inside the vacuum bag by immersion in running water at 17 to 19 °C. The whole legs were cooked in an electric oven, until reaching an internal temperature of 65 to 70 ºC as measured with a thermocouple (JENWAY 2000). Once cooked, the semimembranosus muscle was extracted and cut into 2 x 2 cm subsamples. These were individually wrapped in aluminum foil previously coded with a random three-digit number. The subsamples were kept warm in an electric oven preheated to 60 ºC and then served to tasters in tasting booths, one by one in random order. The tasters consisted of a trained panel of seven tasters, selected and trained according to international standards (ISO 8586)[11], and belonging to the analytical panel of the Sensory Laboratory of the Department of Bromatology and Food Technology of the University of Cordova. Samples from the 21 legs were analyzed in six sessions of no more than 1 h, each taster evaluating a maximum of four samples per session. This methodology is an adaptation of an established methodology for sensory analysis of meat from small ruminants[12]. All analyses were done near mid-day (1200 to 1300 h) in the tasting room of the Córdoba Hospitality School. Tasters cleared their palate with mineral water between samples. Six sensory attributes were analyzed: 1 for appearance (color intensity); 1 for smell (overall smell intensity); 3 for texture (tenderness, mastication and juiciness); and 1 for aroma (overall aroma intensity). Each attribute was graded using an unstructured linear scale that was 10 cm in length and anchored 1 cm from either end. Qualitative evaluations were done of odor (orthonasal) and aroma (retronasal) notes and basic flavors.

The quantitative sensory attributes were analyzed using a two-way analysis of variance (ANOVA) (production system x breed), using the General Linear Model (GLM) of the IBM SPSS for Windows statistical package (version 22.0; IBM Corp., Armonk, New York, USA). An additional ANOVA was done for each sensory attribute to assess whether the panel had worked as a group. After parameter analysis, a factor analysis was run using the principal components (PC) method and selecting those factors with an associated eigenvalue greater than 1.

The results indicated that the panel worked as a group for all the quantified sensory attributes ($P>0.05$). Differences between production systems ($P<0.05$) were found for all sensory attributes except color intensity and overall aroma intensity (Table 2). Differences were also identified between breeds for overall smell intensity ($P<0.001$), tenderness ($P<0.01$) and juiciness ($P<0.01$), as well as for the interactions (production system x breed) for color intensity ($P<0.001$) and tenderness ($P<0.05$).

Table 2: Descriptive measures (mean ± standard error) and analysis of variance (production system x breed) for sensory attributes of analyzed suckling kid meat

Attributes	Production System (PS)		Breed (B)		Significance		
	Organic (n=12)	Conventional (n=9)	Blanca (n=12)	Payoya (n=9)	PS	B	PS × B
Color intensity	4.9±0.19	5.2±0.16	5.1±0.16	5.0±0.19	ns	ns	***
Overall smell intensity	5.8±0.07	6.2±0.08	5.8±0.08	6.1±0.05	***	***	ns
Tenderness	4.3±0.11	5.0±0.17	4.5±0.13	4.7±0.17	***	**	*
Mastication	5.0±0.15	4.5±0.19	4.9±0.16	4.5±0.17	***	ns	ns
Juiciness	4.1±0.12	3.8±0.16	4.2±0.15	3.7±0.07	*	**	ns
Overall aroma intensity	5.4±0.07	5.8±0.10	5.4±0.07	5.8±0.09	ns	ns	ns

* $P<0.05$; ** $P<0.01$; *** $P<0.001$; ns= not significant.

Suckling kid meat from the organic systems had less intensity of smell and a softer, more tender and juicier texture than that from the conventional systems. This is partially supported by previous results produced using the same set of animals as in the present study. In this earlier study water retention capacity (WRC) and texture or meat shear resistance exhibited almost no differences between production systems in both breeds[7,8]. The exception was Payoya kids from the organic system, which had a higher WRC than the other systems, providing some support for the positive results observed in organic Payoya kids in the present study. No similar studies on differences in meat sensory quality between suckling kids in organic and conventional systems have been published to date, but some have addressed differences in kid meat sensory attributes between animals raised in different feeding regimes. For example, a study of the sensory profile of meat from Blanca Serrana Andaluza kids slaughtered at 19 kg only found a higher overall aroma intensity in meat from intensive systems (6.2) than in meat from extensive systems (5.2), which is attributed to higher fat content in the former[13]. Other studies[14] identified differences in sensory attributes between the meat of suckling kids fed with natural milk or a milk substitute. The smell and taste of meat from kids fed the milk substitute was stronger, despite the lack of differences in the percentage of intramuscular fat between the two diets. These differences are attributed to possible variations in the degree of unsaturation of intramuscular fat in response to differences between the diets.

The feed regime of the mothers of the kids used in the present study was similar, suggesting that inter-system variations in the meat sensory profile could be attributed to the nutritional contributions from grazing and the feed concentrate supplements[5,6]. In addition, no differences in intramuscular fat content were observed between meats from the two systems[5,6]. However, differences in sensory attributes between production systems could be partially due to the higher percentages of some fatty acids in the

intramuscular fat of both breeds when raised under organic conditions; in the Blanca Andaluza they were C17:0, C17:1, C20:1, C20:4 n-6, C22:2 and some n-3 fatty acids (omega-3 docosahexaenoic acid C22:5-DPA- and C22:6-DHA-)[5], in Payoya they were C14:0, C18:1 trans-11- (VA) and the n-3 fatty acids C20:5 (EPA), DHA and DPA[6]. This is supported by a recent study on the effects of adding a milk substitute (16 % dry matter) to kid diets on meat sensory quality[15]. Compared to low DHA levels (0.9 %), addition of a high levels of DHA (1.8 %) produced meat with an unpleasant smell and taste and low general acceptance scores. This suggests that, because the animals were very young, they were depositing high quantities of DHA in intramuscular fat, leading to the lower sensory quality rating. Dietary DHA intake of the evaluated kids was not quantified but its content in the meat was higher in those from organic production (0.13 to 0.19 %) than in those from conventional production (0.9 to 0.10 %). Higher intake did not of itself improve the sensory attributes of the organic meat. Perhaps the differences in sensory quality observed here could be explained by this minor difference in DHA levels in conjunction with other fatty acids.

In the inter-breed comparison, the Blanca Andaluza meat had lower odor intensity and a softer, more tender and juicier texture than the Payoya meat. This could be explained in part by the higher meat texture values of the Payoya meat (7.26 kg/cm^2) compared to Blanca Andaluza meat (5.59 kg/cm^2) (P<0.001, unpublished data). Differences in meat sensory attributes have been reported for different goat breeds and genotypes[16,17], but very few publications address meat sensory quality in the two indigenous breeds studied here, and none compare them. Animal breeds can affect quality and even justify establishing a quality brand[18].

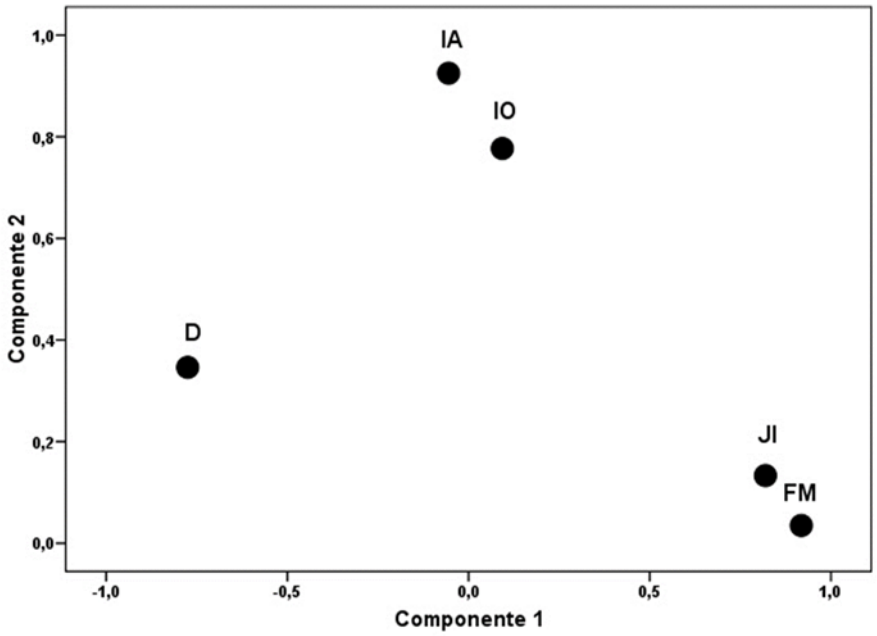
In the qualitative analysis of meat sensory attributes by breed and production system (Table 3), the Blanca Andaluza breed exhibited differences in the odor and aroma descriptors and the basic flavors. Kid meat from the organic system was described as having olfactory notes of cooked meat and metallic flavor while that of the conventional system had a cooked meat olfactory note as well as the smell/aroma of liver and kid and an acid flavor. For meat from Payoya breed kids no clear differences between production systems were apparent in the odor and aroma descriptors, but in terms of basic flavors the organic meat was tasty while the conventional meat had a slightly higher metallic flavor.

Table 3: Frequencies (%) of qualitative analysis descriptors (odor/aroma and basic flavors) of suckling kid meat by breed and production system

Descriptor	Blanca Andaluza		Payoya	
	Organic (n=6)	Conventional (n=6)	Organic (n=6)	Conventional (n=3)
Odor and aroma:				
Cooked meat	100	67	83	33
Liver	17	100	50	67
Kid	0	50	0	0
Urine	0	17	0	0
Basic flavors:				
Tasty	17	17	50	0
Metallic	67	0	50	67
Acidic	0	50	17	0

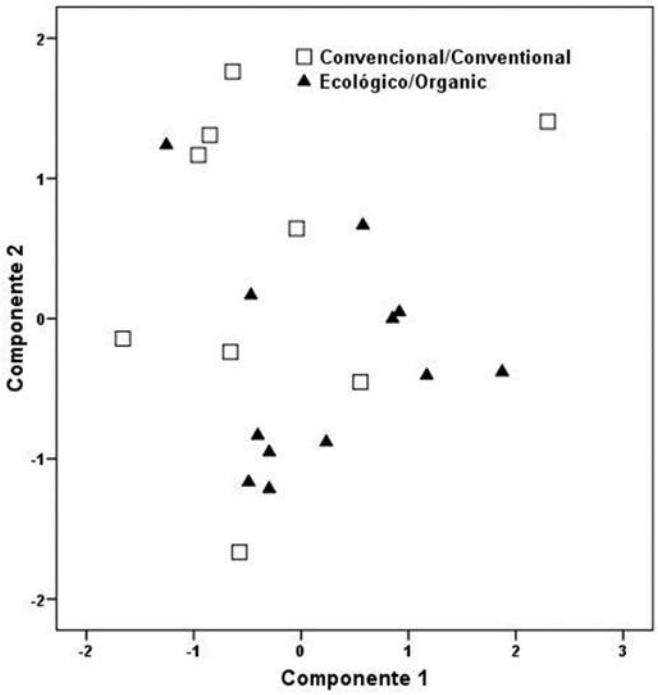
A principal component analysis (PCA) was run in an attempt to group the samples by production system and breed. The first two principal components (CPs) explain almost 66 % of the total variance in sensory quality attributes (37.86 and 27.88 %, for the first and second, respectively). The CP_1 is formed mainly by the texture attributes mastication and juiciness (right of graph), and tenderness (left) (Figure 1a). The CP_2 is characterized by the quality attributes intensity of smell and aroma (both at top of graph). In the PCA for production systems (Figure 1b), in the plane defined by the two CPs, the results are variable. However, organic system kids tended to be located on the right side (greater juiciness and mastication, and less tenderness) and lower portion (less intensity of smell and aroma), whereas conventional system kids tended to be in the left and upper portions. Again, the PCA for breeds is variable, but two general groups can be seen. That in the lower portion corresponds to Blanca Andaluza (less intensity of smell and aroma) and that on the left corresponds to Payoya (less juiciness and mastication).

Figure 1: Principal components factorial analysis

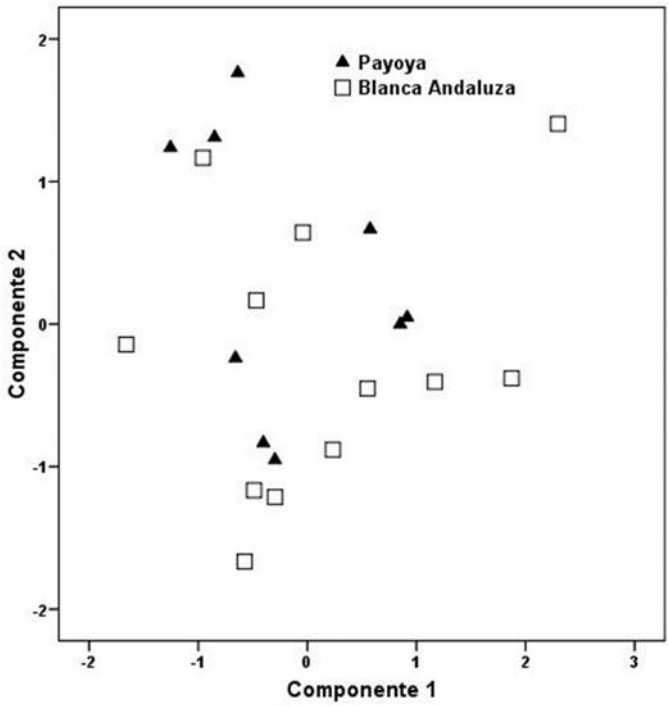


D: Dureza. IA: Intensidad de Aroma. IO: Intesidad de Olor. JI: Jugosidad Inicial. FM: Facilidad de Masticación.
D: Terderness. IA: Aroma Intensity. IO: Odor Intensity. JI: Initial Juiciness. FM: Mastication.

a) Kid meat sensory attributes in plane defined by two principal components.



b) Kids by production system in plane defined by two principal components.



c) Kids by breed in plane defined by two principal components.

Overall, the sensory quality evaluation showed meat from organically-produced Blanca Andaluza kids to have better sensory attributes (more tender, juicier, greater mastication) and less odor intensity than those from conventional systems and/or the Payoya breed. For the Blanca Andaluza breed there were clear differences between systems for the smell and aroma descriptors and basic flavors, whereas for the Payoya breed there were only clear differences between systems for the basic flavors. Although the samples exhibited broad variability, these preliminary results suggest that transitioning from conventional grazing systems to organic ones could improve meat sensory quality. Further research using larger samples is still needed to more clearly determine the possible benefits of this switch in systems.

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