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Quality and Sensory Evaluation for Goat Meat Using Generalized Procrustes Analysis

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Abstract: The aim of this study was to examine relationships among experts, sex, genotypes and sensory variables by Procrustes analysis. About 10 meat samples involved different genotypes and sex were evaluated by 12 expert assessors for four sensory characteristics (color, texture, taste-odor and acceptability). The attributes were assessed using a nine-point (9: extremely enjoy, 1: extremely dislike) scale. The first two dimension of the analysis accounted for 63.19 and 21.11% of the consensus variance, respectively. As a result of evaluating 12 assessors, it may be concluded that meat of Angora goat has been reflected texture, acceptability and taste-odor of sensory characteristics while that of hair goats has color.

Key words: Castration, sensory, dimension, configuration, consensus, Turkey

INTRODUCTION

Goat farming is widespread in Turkey, the Aegean and Mediterranean regions. Goat meat is preferred by consumers in these regions. Mainly, the goat meat is known with low fat content. It has been reported that goat meat has contained high amounts of polyunsaturated fatty acids than sheep meat (Banskalieva *et al*., 2000). In recent years, quality of animal products becomes important as well as quantity in developing countries as developed countries. Recently, the main objective of the work on improving meat quality is consumer preferences for products. The color, tenderness and sensory properties are important in affecting meat quality acceptability.

The sensory qualities of meat remain one of the primary factors influencing consumer satisfaction. In addition, sensory analysis performed by trained panelists is the most appropriate tool to explain differences between treatments as perceived by humans (Rodrigues and Teixeira, 2009).

Generalized Procrustes Analysis (GPA) is an increasingly popular tool to evaluate sensory and quality of food. In GPA the data matrices of individual panelists are subjected to rotation and optionally, transformation and stretching/shrinking to maximize the agreement between the panelists. It uses an iterative algorithm to find rotation and transformation matrices and scaling factors which minimize some measure of the distance between the matrices, the loss function. It has the advantage of being a multivariate method thus dealing with all descriptors and all panelists at once. GPA calculates the consensus configuration of the sample and enables us to present graphically results in two dimensional map.

There are only a few reports included the relationships among attributes, sex, experts and genotypes. The aim of this study is to examine relationships among expert (assessors), sex, genotypes and sensory characteristics (attributes) by means of GPA and it is also aimed to present graphically the results of GPA in two dimensions.

MATERIALS AND METHODS

Samples and panels: Female, male, Early (E) castrated and Late (L) castrated animals from three genotypes (Akkeci goat (A). Angora goat (An) and native Hair goat (H)) were included in the study. From the sensory characteristics; color, texture, taste-odor and acceptability were considered to evaluate in the samples taken from these animals. Sensory evaluation was carried out whole muscles of long-leg by twelve panelists. Long-leg muscles cut into approximately 1×1 cm sub-samples. Samples were cooked at the pressure cooker for 30 min. Then, they were coded and serving sequence was randomized. The attributes were assessed using a nine-point (9: extremely enjoy, 1: extremely dislike) scale (Pena *et al*., 2009).

Statistical analysis: GPA was used to examine the relationships among assessors (experts or panelists). The data matrices of 10 (meat samples) by 4 (attributes)

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for 12 assessors were matched to find a consensus using the XLSATAT software. The first two axes obtained in the consensus configuration were interpreted.

RESULTS AND DISCUSSION

These data sets of 10 rows (genotypes samples) and from 12 columns (attributes) were submitted to GPA using XLSATAT software.

The first result is the PANOVA table was shown in Table 1. PANOVA table summarizes the efficiency of each GPA transformation in terms of reduction of the total variability. In Table 1 the table that the largest effect was due to the translation step (the highest F value and the lowest p-value). At the same time, scaling and rotation steps have also significantly contribution to reducing between panels deviations.

A large degree of consensus was found among the 12 panels with regard to the configuration of the ten groups (genotypes and sex combinations). After optimization the variance accounted for by the consensus was 83.2%.

Figure 1 shows the residuals by object after the transformations. The Angora Late Castrated group has the smallest residual. This indicates that there is most probably a consensus between experts.

Figure 2 shows the residuals for experts by configuration after the transformations. Figure. 2 show that residuals for experts are very close to each other. Moreover Expert 4 and Expert 9 have the highest residuals Expert 4 and 9.

Table 1: Procrustes Analysis of Variance (PANOVA) table

Sources	df	Sum of squares	Mean squares	F	Pr>F
Residuals after scaling	319	362.2680	1.136		
Scaling	11	28.5620	2.597	2.286	0.011
Residuals after rotation	330	390.8300	1.184		
Rotation	66	210.8280	3.194	2.813	<0.001
Residuals after translation	396	601.6580	1.519		
Translation	44	223.5920	5.082	4.475	<0.0001
Corrected total	440	825.2500	1.876		

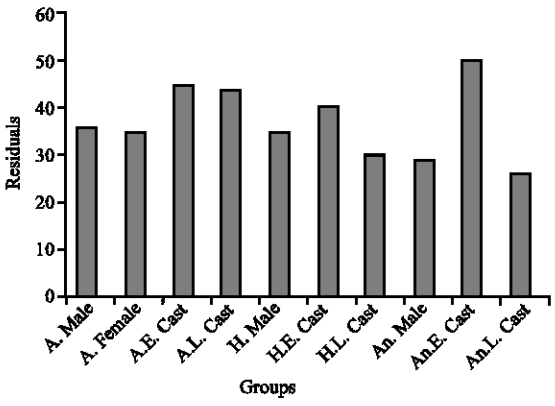

Fig. 1: Histogram of residuals for the genotypes

Scaling factors of the GPA transformations which means there are no matched consensus for were shown in Fig. 3. A factor <1 indicates that the corresponding expert was not using the rating scale as widely as the others. A factor higher than 1 indicates that the corresponding expert was using a wider scale than the other experts. The experts 1 and 4, 5, 6, 8, 9, 11 and 12 tend to use a wider scale than the other experts.

Permutation test was used to verify how many dimensions should be retained to display the results. As a result of permutation test, we can conclude that two dimensions are enough.

The next results correspond to the results of the PCA step (unstandardized PCA). While the GPA already includes a rotation step for each configuration so that it matches the consensus configuration, the PCA corresponds here to the optimal transformation of the consensus configuration under the usual PCA constraints. The PCA transformation is then applied to each configuration corresponding to each expert.

Eigenvalues for the factors and correlations between dimensions and factors were shown in Table 2. When Table 2 is examined, it was shown that the highest eigenvalue (2.000) is belong to the first factor with 0.668

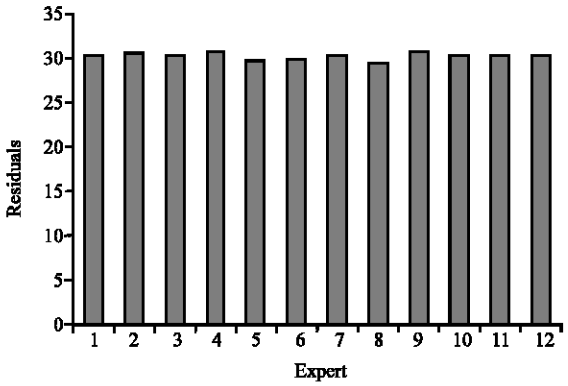

Fig. 2: Histogram of residuals for the experts

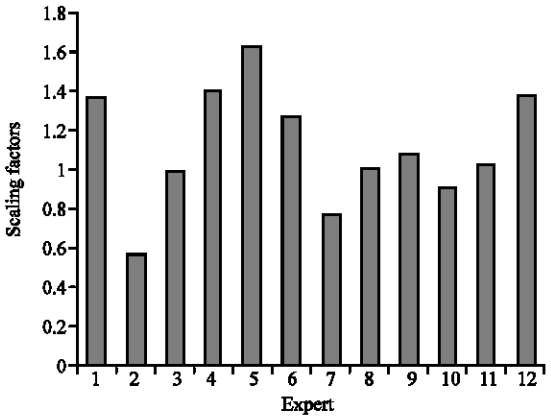

Fig. 3: Scaling factor for each configuration

Table 2: Eigenvalues and correlations between dimensions and factors

Parameters	F1	F2	F3	F4	Variables	F1	F2
Eigenvalue	2.000	0.668	0.412	0.085	Color	-0.362	-0.439
Variability (%)	63.187	21.108	13.015	2.690	Texture	0.792	-0.333
Cumulative (%)	63.187	84.295	97.310	100.000	Taste-Odor	0.942	-0.002
					Acceptability	0.818	-0.042

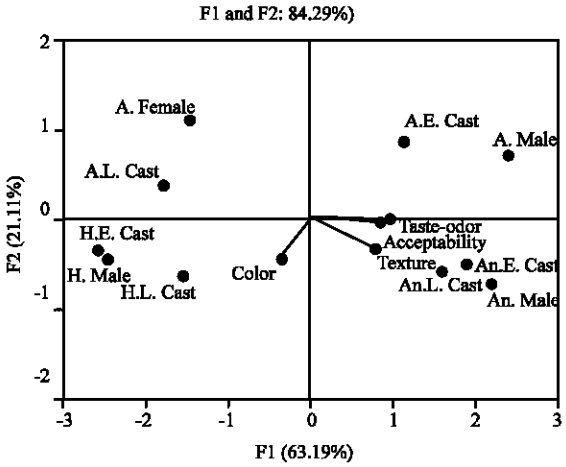

Fig. 4: Configuration map of sensory characteristics and groups

it is followed by the second factor. The eigenvalues show how much of the variability corresponds to each axis. We can see that here we have 84.295% of the variability represented on the first two axes.

While color is negatively correlated with the 2nd Factor, other sensory variables (texture, taste-odor and acceptability) have positively correlation with the first factor (Table 2).

There is highest correlation (0.942) between taste-odor and the first factor. Thus it can be emphasized that the first factor was formed by texture, taste-odor and acceptability on the other hand only color from the sensory variables formed the second factor. The view of the relationships between sensory variables and groups with two-dimensional space is shown in Fig. 4.

While 63% of consensus variance was accounted for first dimension, the second dimension explained only 21.11% of the variance. According to first dimension, Akkeci early castrated group was related to Akkeci male groups and Akkeci female group was related to Akkeci late castrated group. When the first dimension is taken to consideration, Akkeci female and Akkeci last castrated groups are negatively related to Akkeci male and early castrated groups. On the other hand, all of these groups were located in the positive region for dimension 2 and there was no correlation between Akkeci groups and sensory variables. Thus it may be stated that early castration in Akkeci male goat not cause any changes in masculinity characteristics while late castration get closer to femininity.

Hair and Angora goats were grouped in the same region for the dimension 2 as they were different for the dimension 1. From the sensory characteristics while texture, acceptability and taste-odor were highly correlated with Angora goat only color was associated with castrated and male groups of hairy goat. There is no difference between early and late castrated groups of Angora goats. In addition, these two groups are highly similar to Angora male group. Moreover, early castrated group of hair goat is highly similar to males of hair goat and these two groups are closed to late castrated group of hair goat. As a result of evaluating 12 assessors, it may be concluded that meat of Angora goat has been reflected texture, acceptability and taste-odor of sensory characteristics while that of hair goats has color.

Also it may be stated that meat of Angora goat is more preferable than that of hair goat for texture, acceptability and taste-odor sensory characteristics on the other hand, meat of hair goat has been seemed better for color characteristic of sensory.

Sensory quality of venison has been studied Hutchison *et al.* (2010). They reported that there was a significant difference in the consumer scores for tenderness. Jahan *et al.* (2005) stressed that differing production regime was on the basis of appearance and texture aroma and flavor in chicken breast meat.

Adam *et al.* (2010) notified that color is important sensory characteristics for consumer. In this study it was found that color is related to sex in hair goat.

Carlucci *et al.* (1998) emphasized that the rearing system affected texture more than odor and flavor whereas sex had little effect on tlextural attributes compared with odor and flavor. In addition, Johnson *et al.* (1995) stated that castration influenced meaty odor and flavor. The similar result also was stated by Vipond *et al.* (1995). In this study, it may be concluded that sex had moderate effect on texture, acceptability and taste-odor in Angora goat and had little effect on color in hair goat. This result largely agreed with of previous studies.

CONCLUSION

In this study, the relationships among experts, sex, genotypes and sensory variables were examined by

Procrustes analysis. The results show that there are moderate correlations among these variables. It may be concluded that the relationships between sensory and other variables can be modeled by Procrustes analysis and the researcher may be obtained valuable information by this analysis. However, further researches are needed to better understand the relationships between sensory and other variables.

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