www.roavs.com ISSN: 2223-0343 (ONLINE)
RESEARCH OPINIONS IN ANIMAL & VETERINARY SCIENCES

The use of principal component analysis to characterize bulls aged between 14 and 26 months in Tunisia

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Abstract

A total of 213 bulls aged between 14 and 26 months were used to study morphometric measurements allowing the characterization of these animals. These were Holstein, Limousin, Charolais, Salers and crossbred animals. Measures of the height at withers and pelvis, the width and girth of the chest, the width at pelvis, and the depth of chest, in addition to the weight and age at slaughter, were recorded. Statistical analyses were performed by the use of the principal component analysis as well as a cluster analysis using the "WARD" method. High correlations were determined between the weight, the width at pelvis (r = 0.88), the chest width (r = 0.87) and the chest perimeter (r = 0.86). Principal component analysis determined two main components that could characterize animals. The first component is related to the conformation and the second one to the frame size. Cluster analysis based on the two main components showed the existence of four groups of bulls defined as: First group of bulls with a low conformation and a small frame size. Second group of bulls with a medium conformation and a large frame size. Third group of bulls with fairly good conformation and a small frame size. Fourth group of bulls with a good conformation and a large frame size. In conclusion, this study provides valuable information for the characterization of bulls marketed in Tunisia. It also gives the possibility of establishing a classification grid for live bulls which can serve the needs of the red meat sector operators.

Keywords: Bulls; characterization; live measurements; classification

To cite this article: A. Slimene, C. Damergi, L. Chammakhi, T. Najar and M. Ben Mrad, 2012. The use of principal component analysis to characterize bulls aged between 14 and 26 months in Tunisia. Res. Opin. Anim. Vet. Sci., 2(3), 207-211.

Introduction

Several countries use classification systems of live cattle for the quality assessment of living animals based on several criteria related to animal conformation. In Tunisia, animal transactions take place mainly through subjective evaluation of young bulls slaughtered. Thus, there is a need to develop a classification scheme of living bulls based on objective measures, which allows the determination of different classes on the market and facilitate commercial tasks between various operators involved in the red meat industry in Tunisia.

Several authors use principal component analysis to characterize carcasses and living animal by performing morphometric measurements. (Brown et al., 1973; Destefanis et al., 2000; Alberti et al., 2005; Alberti et al., 2008; Santos et al., 2008). Fisher (1975) reported that morphometric measures taken on the live animal have been considered as a simple means for recording parameters related to the shape and the growth of the animal. Other researchers studied the different relationships between linear body measurements on live animal and some characters with regards to performance such as slaughter grade, carcass grade and dressing percentage (Kohli et al., 1951; Cook et al., 1951; Kindwell., 1955; Tallis et al., 1959). On the other hand, studies were conducted to determine the relationship between body measurements and conformation score or frame size and shape (Ternan et al., 1959; Tatum et al., 1986).

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The main objective of this paper is to determine the parameters characterizing young bulls aged between 14 and 26 months using objective measures. In this study, we used the principal component analysis as well as a cluster analysis based on the identified components in order to determine the main classes of live bulls that could be present in the Tunisian live animal market.

Materials and Methods

A total of 213 young bulls were used in this study. They were divided between local dairy type (109 Holstein), imported pure breed beef (89) and crossbred beef animals (15). Beef bred were: Limousin (16), Charolais (58) and Salers (15). Local dairy breed were fed with oat silage, hay and concentrate formulated at the farm. While imported beef were only fed by straw and concentrate formulated according to the animal's need.

Data recorded on live animals were the weight and the age at slaughter. Measurements were recorded according to the method of De Boer et al. (1974):

- Chest girth: smallest circumference measured behind the shoulder at the same level
  as width and depth of chest,
- Depth of chest: measured behind the shoulder at the same level as width of chest,
- Width of chest: width immediately behind the shoulder blades,
- Height at withers: measured from the highest point of the withers, between the shoulders,
- Height at pelvis: measured from the anterior edge of the sacrum between the hips,
- Width at pelvis: measured at trochanters,

Length and perimeter measurements were taken by tape measure, whereas width and depth measurements were taken by caliper.

Statistical analysis was performed by SAS software version 9.1. Principal component analysis aims to identify variables that characterize different groups of living animals. Cluster analyses based on principal components were performed to distinguish between different classes of living animals.

Results and Discussion

Table 1 shows means, standard deviations and the coefficient of variation of the variables. The coefficient of variation of some variables, such as height at withers, height at pelvis, depth of chest, is lower than 10%, while some others, like width at pelvis, width of chest, slaughter live weight is higher. These results were quiet similar to those reported by Kindwell (1955) for measurements recorded for the height at withers, the chest depth and the height at pelvis. However, the other measurements had higher coefficient of variation except for live weight which has a lower value. Compared to values reported in this study, Ternan et al. (1959) found lower coefficient of variation.

Table 2 shows the correlation coefficients between the 8 studied variables. There was a high positive correlation between live weight at slaughter and chest girth, width of chest and width at pelvis. For instance, the weight presented a high positive correlation with the perimeter of the chest ($r = 0.86$), the width of the chest ($r = 0.87$) and at pelvis ($r = 0.88$). These results were similar to those reported by Tatum et al. (1986) and Kindwell (1955). The height at withers is however, negatively correlated to live weight at slaughter ($r = -0.24$). Tatum et al. (1986) found a high positive correlation for these last two parameters. We did also found a negative correlation between height at withers and width at pelvis. Similarly, the chest perimeter showed a high positive correlation with the chest width ($r = 0.86$) and width at pelvis ($r = 0.86$). Indeed, the width at pelvis is highly correlated with the width of the chest ($r = 0.88$), whereas the latter parameters presented a negative correlation with the height at the withers of the animal.

The findings of Brown et al. (1956) are not consistent with those recorded in our study mainly those related to the correlation between the body weight and height at withers and the chest depth. The correlation between the depth of the chest and the body weight reported in our study is significantly lower ($r = 0.26$ vs. $r = 0.67$) than that found by Brown et al. (1956). Wanderstock and Salisbury (1946) reported similar tendency showing a high correlation between weight at slaughter and height at withers and heart girth. However, Yao et al. (1953) reported low correlations between the variables related to the height at pelvis, the width of the chest ($r = -0.07$) and the width at pelvis ($r = 0.17$). These results, as a matter of fact, are consistent with those found in our study where correlations are low regarding these parameters. Kohli et al. (1951) reported high positive correlation between chest width and height at withers and a negative correlation between width of shoulders and height at withers. These results are not in concordance with those found in our study.

Results of principal component analysis are summarized in Table 3 and Table 4. Two main components in descending order were extracted in this analysis. The first component has an opportunity to explain 56.73% of the variability, while the second component has just 24%. Both components explained 80.77% of the total variability.

Table 4 shows high correlations between the first component, the weight ($r = 0.92$), the perimeter of the chest ($r = 0.95$), the width at pelvis ($r = 0.94$) and the

Table 1: Mean, standard deviation and coefficient of variation of the variables

Parameters	Mean	S.D	C.V
Slaughter live weight (kg)	559.22	116.89	20.90
Slaughter age (months)	19.25	2.34	12.17
Height at withers (cm)	131.55	4.57	3.47
Width of chest (cm)	47.54	7.54	15.85
Height at pelvis (cm)	137.53	4.30	3.13
Width at pelvis (cm)	54.05	7.17	13.27
Depth of chest (cm)	68.69	2.63	3.83
Chest girth (cm)	189.77	12.37	6.52

S.D: Standard deviation, CV: coefficient of variation

Table 2: Correlation coefficients between the live body variables

Parameters	Age	LW	CD	CG	WC	WH	HW	HH
Age								
LW	0.27**							
CD	0.39**	0.26**						
CG	0.32**	0.86**	0.45**					
WC	0.14*	0.87**	0.22**	0.86**				
WH	0.23**	0.88**	0.27**	0.86**	0.88**			
HW	0.23**	- 0.24**	0.52**	-0.11	0.29**	-0.29**		
HH	0.28**	0.14*	0.53**	0.22**	0.04	0.10	0.67**	

** =P<0.001 * =P<0.01, levels of significance

Live weight (LW); Chest depth (CD); Chest girth (CG); Width of chest (WC); Width at pelvis (WH); Height at withers (HW); Height at pelvis (HH).

Table 3: Results from the principal component analysis for the two first principal components

Component	Eigen value	Portion of variance (%)	Cumulative Variance (%)
1	5.67	56,73	56.73
2	2.40	24,04	80.77

Table 4: Principal component loadings

Parameters	CP1	CP2
Age (months)	0.35	0.42
Live weight (kg)	0.92	-0.17
Chest depth (cm)	0.46	0.68
Chest girth (cm)	0.95	-0.02
Width of chest (cm)	0.90	-0.27
Width at pelvis (cm)	0.94	-0.21
Height at pelvis (cm)	0.29	0.82
Height at withers (cm)	-0.11	0.90

width of the chest (r = 0.90). While on the other hand, the second component presented high correlations with the height at the withers (r = 0.90), height at pelvis (r = 0.82) as well as the depth of the chest (r = 0.68).

Moving forward, Figure 1 represents the 8 initial variables in the plane formed by the axes representing the two main components 1 and 2. The coordinates of these variables are the correlations of variables with the component 1 and 2. Component 1 shows a positive high correlation with the weight, the chest width, the width at pelvis, and the chest girth but a negative correlation with the height at the withers of the living animal. The second component presented a positive high correlation with the height at withers, the height at pelvis and the chest depth of the living animal. Hence, the principal component analysis allowed identifying two groups of variables and visualizing the relationships that exist between them. So, the first main component is correlated with variables related to the conformation of the living animal while the second can be considered as a skeleton indicator axis.

Results of cluster analysis are shown in figure 2. The application of a cluster analysis based on two previously identified components permitted the determination of four classes of live animals that could be described as following:

- Cluster 1: bulls with fairly good conformation and a small frame size.
- Cluster 2: bulls with a good conformation and a large frame size.
- Cluster 3: bulls with a medium conformation and a large frame size.
- Cluster 4: bulls with a low conformation and a small frame size.

Conclusion

This study revealed the importance of morphometric measurements in the assessment and qualification of live bulls aged between 14 and 26 months. The use of principal component analysis has allowed the identification of two groups of components as well as the distinction between the different classes of young bulls. Cluster analysis permitted the distinction between different groups of bulls raised in Tunisia and slaughtered for meat production.

Results of the present study also, provided valuable information regarding the live weight and the height at pelvis that can be used to develop a classification gird for live bulls in the country. Such a gird serve as a basis for the negotiation between various operators of the meat sector during sale transactions of bulls for slaughter.

Acknowledgments

We are grateful to Mr Haoula Kamel from the Office of Public Lands and to the private farmer, who permitted us to take measurements on live animals at different farms. We also wish to express our sincere gratitude to Mr Jbeli Mounir and Msadek Ben Romdhane from the Tunisian Ministry of Defense for their help and assistance.

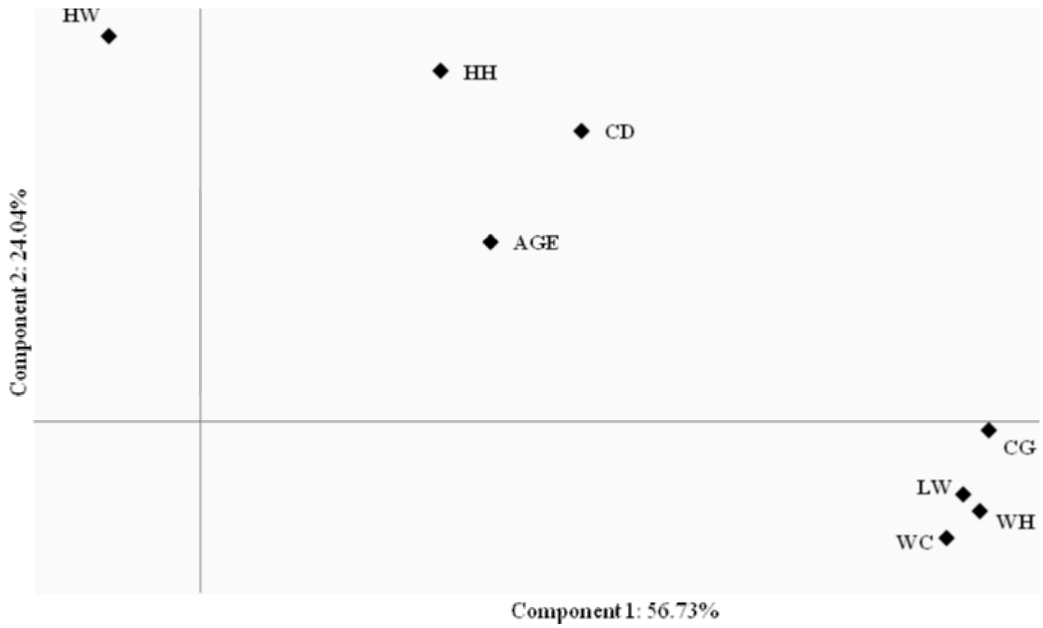

Fig. 1: Projection of the morphometric measures in the plane defined by the two first components (PCs).

Live weight (LW); Chest depth (CD); Chest girth (CG); Width of chest (WC); Width at pelvis (WH); Height at withers (HW); Height at pelvis (HH).

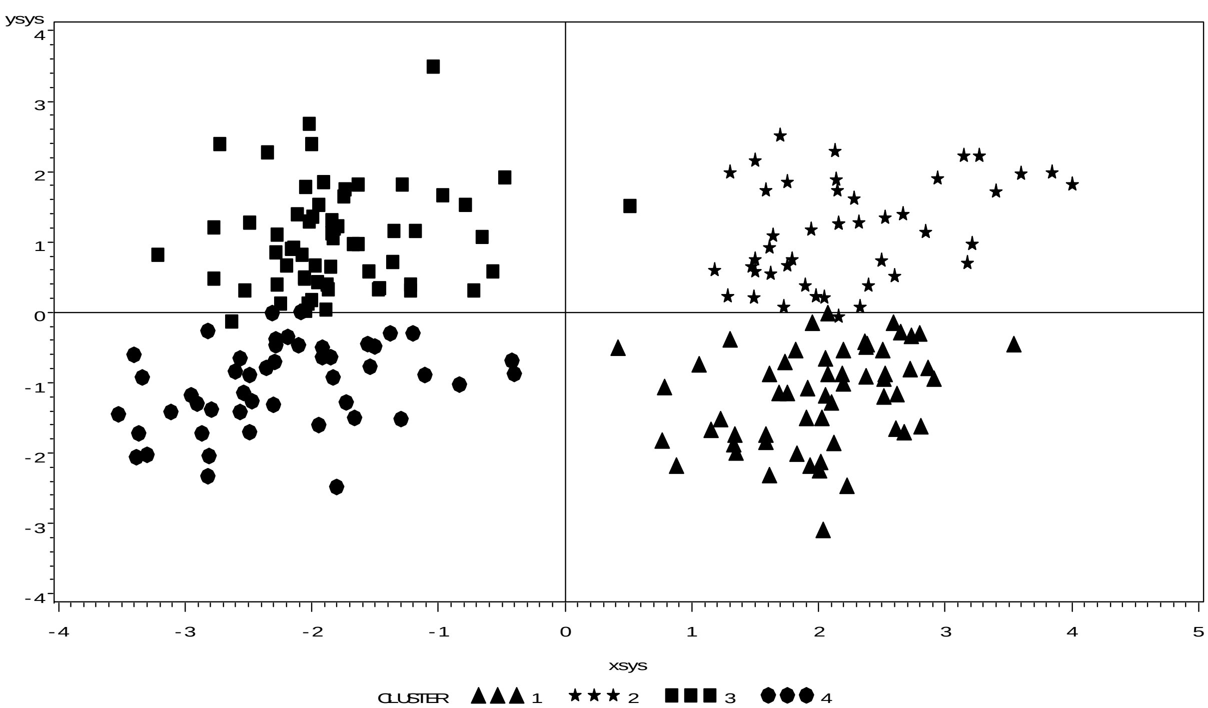

Fig. 2: Projection of the morphometric measure of the four animal groups identified by the cluster analysis based on the two principal components.

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