RETAIL CUT PERCENTAGES PREDICTION OF CROSSBREEDING YELLOW CATTLE BASED ON PRINCIPAL COMPONENT ANALYSIS

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Keywords: retail cut percentage, cattle, principal component analysis, BP artificial neural network

Introduction

The retail cut characteristic of beef carcass mainly indicates the quality of the cattle and the weight of the cattle. The beef grade standard includes quality grade standard and weight grade standard. Retail cut percentages of the beef carcass is the main index of the beef weight grade standard (Chen, 2005). Likewise, the retail cut percentages is an important factor to the feeder. It can get more economical benefit to the feeder if the cattle offer high retail cut percentages.

Many countries have made equations to predict the cattle retail cut percentages, such as USA and Japan (Harris, 1995). The equations not only can predict the cattle retail cut percentages, but also can guide the breed and management of crossbreeding yellow cattle (Voges, 2006). In China, the method is not maturity enough, so it is an important and urgent thing to find out a method to predict the cattle retail cut percentages. The objective of the present study was to predict the retail cut percentages using principal component analysis (PCA) and BP artificial neural network which adapt to crossbreeding yellow cattle of north of China.

Materials and Methods

The trial was carried out on 75 crossbreeding yellow cattle at 18-50 months of age. According to Beef Grade Standard (NY/676-2003), the cattle were slaughtered at abattoir after 24-hour fasting, thus they did not suffer stress due to transport. After chilled 48 hours, the carcasses were fragmented. The cattle gross weight (GW, kg), cold carcass weight (CCW, kg), hot carcass weight (HCW, kg), carcass length (CL, cm), carcass width (CW, cm) were measured directly. Because the net muscle weight (NMW, kg) could not get directly and accurately in production line, bone weight (BW, kg) was measured to show the NMW indirectly. The difference of the CCW and the BW was used to express the NMW. Then the retail cut percentages equation was got from the CCW and BW. Rib eye area (REA, cm^2) was measured by REA ruler at 12-13 rib, fat thickness (FT, cm) were measured by ruler at 3/4 of the rib eye.

$$\mathrm{RCP} = \frac{CCW - BW}{CCW} \times 100\% \quad \text{(RCP is retail cut percentages)} \tag{1}$$

The eight parameters were used to predict the retail cut percentage. At first, the eight parameters of 75 crossbreeding yellow cattle need to be correlation analysis. Because if correlation of the most data less than 0.3, the PCA could not get the good effect. Secondly, the data need to standardization, because the eight parameters had different units and dimension. At last, the PCA was used to reduce the parameter dimension. Multi-indexes were transformed to two or three complex indexes.

After several integrated indexes were got by PCA in Matlab, the indexes were used to predict the retail cut percentages by BP artificial neural network (ANN). 50 crossbreeding yellow cattle data were used as BP ANN training samples. And rest 25 crossbreeding yellow cattle data were used as the BP ANN testing samples.

Results and Discussion

Correlation analysis. There was significant correlation among the indexes except for the FT. The correlation of GW, HCW, CCW and BW were more than 0.9 ($p<0.01$). However, there was faintish correlation between FT and other indexes. Maybe the reason effect the veracity of the measuring result is that the FT of crossbreeding yellow cattle of north of China is thin. Because the correlations among the indexes were more than 0.3 ($p<0.05$) expect for the FT, the indexes was used in principal component analysis to reduce the parameter dimension.

Method of PCA. After data standardization, the dimension of eight parameters turned into the same size. They were used in PCA.

The principal component (PC) vectors: Z=(X1(GW), X2(HCW), X3(CCW), X4(CL), X5(CW), X6(BW), X7(REA), X8(FT)).

The parameter dimension was reduced by PCA. The dimension must less than eight. The contribution rate (CR) of PC went down with the latent root (LR) trend (Figure 1). The LR showed the contribution rate of every parameter. The change trends of the second and the third LR was gradual calm. In the PCA method, the Cumulative contribution Rate (CCR) must more than 85%. In the study, the CCR of first two PCs was 83.9%.

The CCR did not meet the PCA request. The CCR of first three PCs was 94.22% (Table 1), so it could show the most information of the parameters. Therefore, the first three PC were used to predict the retail cut percentages of crossbreeding of yellow cattle.

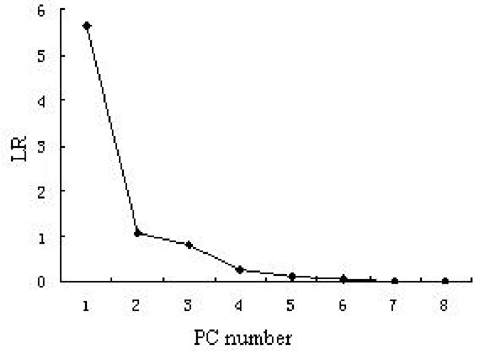

Figure 1. Relation of PC and LR

Table 1. PCA Table

PC	LR(λ)	CR(%)	CCR(%)
Z_1	5.644	70.5539	70.5539
Z_2	1.068	13.3544	83.9083
Z_3	0.825	10.3119	94.2202
Z_4	0.253	3.1679	97.3881
Z_5	0.128	1.5971	98.9852
Z_6	0.070	0.8746	99.8598
Z_7	0.011	0.1395	99.9993
Z_8	5.046e-005	0.0006	100

The PC equation:

$$Z = TX . \qquad (2)$$

$$Z = (Z_1, Z_2, Z_3)', \quad X = (X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8)' .$$

$$T = \begin{bmatrix} -0.407 & -0.411 & -0.410 & -0.401 & -0.309 & -0.330 & -0.360 & -0.04 \\ -0.068 & -0.086 & -0.091 & -0.093 & 0.336 & 0.368 & -0.148 & -0.837 \\ 0.182 & 0.155 & 0.161 & 0.145 & -0.579 & -0.456 & 0.248 & -0.540 \end{bmatrix}$$

Z is PC vectors. X is parameter Vectors. T is coefficient matrix.

Method of BP ANN. The study used three layers ANN include input layer, connotative layer and the output layer. The transform function of connotative layer is logsig. The function of output layer is purelin. The results of equation (2) were used in input layer as input vectors. The results of equation (1) were used in output layer as target vectors. The learning rate was got by maxlinlr function in Matlab. Then the 50 crossbreeding yellow cattle data were used as training samples. The learning rate ascended gradually and the error descended gradually. When it was trained the 84^{th} times, the learning rate arrived to 0.12 and the error under 0.1(figure 2, figure 3). Then the rest 25 crossbreeding yellow cattle were used to test the BP ANN, the accuracy arrived to 92%.

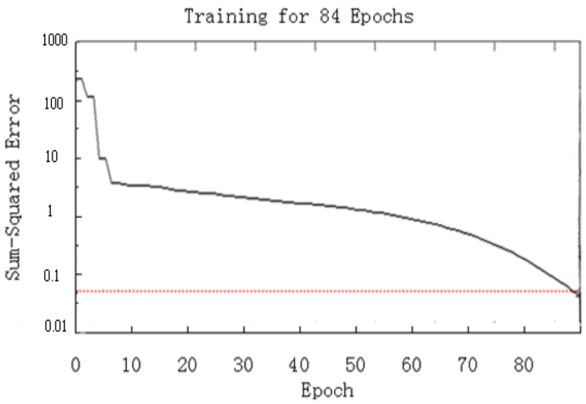

Figure 2. BP ANN Sum-squared Error

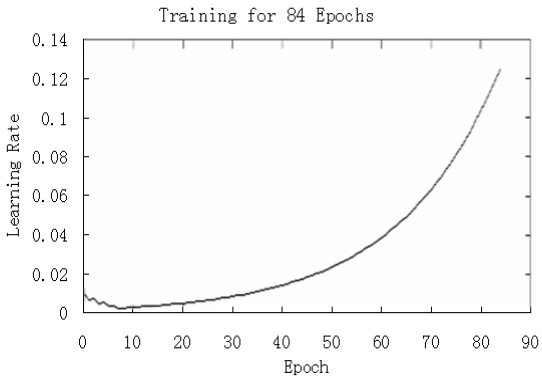

Figure 3. BP ANN learning rate

Conclusions

The correlations of the indexes were more than 0.3 ($p<0.05$) expect for the FT, the indexes was used in principal component analysis to reduce the parameter dimension. The first three PCs could express the most information and the CCR arrived to 94.22%. Then the BP ANN was used to predict the retail cut percentages by the first three PCs. The accuracy of retail cut percentages prediction by PCA and BP ANN arrived to 92%. The study showed that retail cut percentages prediction based on the PCA is feasible.

Reference

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