Evaluation of the Quality of Different Brands of Beef Upper Brain based on Correlation and Principal Component Analysis

Wanyue Hua[1][a], Xiaoning Jiang[2][b], Liting Yan[3][c], Xuefei Hou[1][d] and Huijun Liu[1][e]
[1]*Food Science and Engineering College, Beijing University of Agriculture, Beijing, 102206, China*
[2]*RDFZ Xishan School, Beijing, 100193, China*
[3]*Beijing Yanxi Yueshengzhai Moslem Food Co.,Ltd., Beijing, 101400, China*

Keywords: Beef Upper Brain, Correlation Analysis, Principal Component Analysis.

Abstract: In order to establish the evaluation standard of beef upper brain quality, correlation and principal component analysis were used to comprehensively evaluate the quality of different brands of beef upper brain. Conventional methods were used to determine the color difference (Lab) value, colonies number, pH value, volatile base nitrogen (TVB-N), sensory quality and texture quality indicators of three commercially available beef upper brain. The results showed that the correlation analysis showed that the colonies number and chewiness were two key factors that affected the storage quality of cattle upper brain. Principal component analysis extracted three principal component factors, the first principal component variance contribution was 40.978%, the second principal component variance contribution was 32.993%, the third principal component variance contribution was 11.893%, and the cumulative variance contribution was 85.863%. The original complex comprehensive evaluation model of cattle upper brain quality can be replaced by these three principal components. Using this model to rank the comprehensive meat quality score is: B>A>C. It was expected to provide technical reference and theoretical basis for follow-up researchers to evaluate the quality of beef upper brain.

1 INTRODUTION

Beef had many advantages such as high protein, low fat, rich in minerals, vitamins and a variety of amino acids. It was an indispensable meat food for ordinary people on the dinner table (Bai 2020). According to different processing methods of beef, it can be divided into three categories (hot fresh beef, cold fresh beef, frozen beef)0. Cold fresh beef referred to a low-temperature fresh meat product that rapidly cools and deacidifies the carcass after slaughtered in strict compliance with veterinary inspection and quarantine regulations, and kept it in the range of 0~4°C during the later processing, transportation and sales0. From slaughter, processing to marketing, cold fresh beef had undergone a process of stiffness, de-rigorization and maturation. During storage, the protein was normally degraded, Under the strict control of the food quality and safety management system, the meat quality, color and elasticity of cold fresh meat had been improved, and it had become tender and juicy and has a good taste. At the same time, the decrease of pH caused lactic acid to inhibit the reproduction of microorganisms, made cold Colonies numbers meat safer when eating, and also prolonged the freshness period0. Cold fresh beef was first popular in developed countries in Europe and America, accounting for about 90% of the meat market circulation. At present, developed countries such as Europe, America and Japan had more advanced technology for cold fresh beef processing technology and circulation technology, and the quality control and tracking system were also relatively complete to ensure that the cold beef that people buy for consumption was safe and reliable0.

At present, there were many indicators for evaluating beef quality, but there were few studies

[a] https://orcid.org/0000-0002-2863-9426
[b] https://orcid.org/0000-0003-2165-732X
[c] https://orcid.org/0000-0002-5258-7777
[d] https://orcid.org/0000-0001-7760-8282
[e] https://orcid.org/0000-0001-9527-6728

Hua, W., Jiang, X., Yan, L., Hou, X. and Liu, H.
Evaluation of the Quality of Different Brands of Beef Upper Brain based on Correlation and Principal Component Analysis.
DOI: 10.5220/0011164000003444
In *Proceedings of the 2nd Conference on Artificial Intelligence and Healthcare (CAIH 2021)*, pages 52-57
ISBN: 978-989-758-594-4

and evaluations on the quality of beef upper brain, the weights of various traits were difficult to scientifically determine, and a comprehensive evaluation method for beef upper brain quality had not been established. The principal component analysis (PCA) was to recombine many indicators with certain correlations (such as P indicators) into a new set of independent comprehensive indicators to replace the original indicators0, this evaluation method had been widely used in the field of food quality evaluation. The more the number of indicators measured by this method and the higher the correlation between the indicators, the less the number of corresponding principal components. Comprehensive evaluation using principal component analysis had the advantages of comprehensiveness, comparability, rationality, feasibility, etc0. Therefore, this article selected three commercially available beef upper brains to determine the sensory quality, color difference (Lab) value, colonies number, pH value, total-volatile basic nitrogen (TVB-N) and texture quality indicators, established a principal component analysis evaluation model for beef upper brain meat quality, extracted key influencing factors, and through sensory evaluation to verify the model, in order to provide technical reference for the evaluation methods and standards of beef upper brain quality.

2 MATERIALS AND METHODS

2.1 Materials and Instruments

Three kinds of cold fresh beef upper brain samples were purchased from Hema Xiansheng Supermarket in Changping District, Beijing, stored in ice packs, transported back to the laboratory within 30 minutes, and kept in a refrigerator at 4 ℃ for later use; Plate Counting Agar Beijing Luqiao Technology Co., Ltd.; Hydrochloric Acid Beijing Chemical Plant; Magnesium Oxide, Methyl Red, and Bromomethylphenol Green Sinopharm Group Chemical Reagent Co., Ltd.

YXQ-75G Vertical Pressure Steam Sterilizer Shanghai Boxun Industrial Co., Ltd.; Texture Analyzer US BROOKFIELD; Testo 205 pH measuring instrument Testo International Trade Shanghai Co., Ltd.; CheckMate3 Headspace Analyzer AMETEK Trading Shanghai Co., Ltd.; CM-700d Spectrophotometer Shanghai Gaozhi Precision Instrument Co., Ltd.

2.2 Experimental Method

2.2.1 Sensory Quality Measurement

With reference to the method of Yang Wenting0and others, this experiment selected four indicators of color, smell, viscosity, and broth after boiling as the sensory evaluation indicators of cold fresh beef upper brain. The total evaluation was divided into the average value of the sum of the four indicators. The sensory quality evaluation was performed using a 5-point system, and the evaluation criteria were shown in Table 1. Evaluation by 10 professionals.

Table 1: Sensory Evaluation Table.

Evaluation index	Sensory level				
	5 points (very good)	4 points (good)	3 points (average)	2 points (bad)	1 point (very bad)
Color	Very bright red and shiny	Bright red, shiny	Color dark red, matt	Grayish or pale color, dull	Dark brown color, unacceptable
Smell	Has the peculiar smell of fresh lamb without any peculiar smell	With the smell of lamb, no peculiar smell	Slightly ammonia smell	Smell of ammonia	Smell of corruption, unacceptable
viscosity	Moist surface, not sticky to the touch	The surface is slightly dry, not sticky to the touch	Dry surface, moist cut surface	Dry surface, slightly sticky hands	Extremely dry surface, sticky
Broth after boiling	The broth is transparent and clear, and the fat is agglomerated on the surface with a fragrance	The broth is more fragrant and the fat accumulates on the surface	The broth has no fragrance	The broth is muddy and smelly	Broth is discolored and has a strong peculiar smell

2.2.2 Determination of Flesh Color

Expose the sample to 4 ℃ air to develop color for 30 minutes before measurement0, used a calibrated portable colorimeter to measure the L, a, and b values of the sample every day, each box of beef upper brain was randomly measured at 6 sites, and each site was measured 3 times in parallel, and the average value was taken.

2.2.3 The Determination of the Colonies Number Was Determined

According to the method of GB 4789.2 - 2016 "Determination of the colonies number"0.

2.2.4 Determination of pH Value

Used a hand-held pH meter to directly insert the bovine upper brain sample to determine the pH value of the product. Each box of samples was randomly measured at 3 points and the average value was taken.

2.2.5 The Determination of TVB-N Was Determined

According to GB/T 2009.228 - 2016, the first method of semi-trace nitrogen determination0.

2.2.6 Determination of Texture Index

The hardness, elasticity and chewiness of fresh beef upper brain were measured using the texture analyzer TPA mode. The measurement mode was0: the probe model was T/46, the moving distance was 5 mm, the holding time was 2 s, the trigger load was 2 g, the test speed was 2 mm/s, the recovery time was 5 s, and the cycle was 2 times. Randomly selected the area and take the average of 3 measurements.

2.3 Data Processing

Used SPSS 19.0 software (SPSS company) to perform correlation and principal component analysis on the experimental data, and the data were all expressed as the mean±standard deviation of the 3 parallel results.

3 RESULTS AND ANALYSIS

3.1 Correlation Analysis of the Effects of Different Brands of Bovine Supramencephalon on Sensory Quality

Table 2: Pearson correlation analysis of the influence of different brands of cattle on the quality of the upper brain.

	L	a	b	pH	TVBN value	Colonies number	Hardness	Elasticity	Chewiness	Senses
L	1									
a	-0.02	1								
b	0.278	0.197	1							
pH	-0.359	-0.5	-0.154	1						
TVBN value	-0.468	-0.182	-0.309	0.583	1					
Colonies numbers	-.687*	-0.236	-0.077	0.552	0.826**	1				
Hardness	-0.187	0.52	0.018	-0.749*	-0.096	0.073	1			
Elasticity	-0.636	0.174	0.015	0.143	0.616	0.823**	0.531	1		
Chewiness	-0.419	0.445	-0.23	-0.417	0.248	0.383	0.894**	0.766*	1	
Senses	0.254	-0.189	-0.204	-0.148	-0.586	-0.69	-0.204	-0.571	-0.336	1

Note: *. Significantly correlated at the 0.05 level (two-sided). **. Significantly correlated at the .01 level (bilateral).

Used SPSS software to analyze the correlation between the indicators of different brands of cattle on the brain, The colonies number was significantly negatively correlated with sensory scores and L values, and the correlation coefficients were -0.690 and -687 ($p < 0.05$), which were significantly positive with the TVB-N value and elasticity, the correlation coefficients were 0.826, 0.823 ($p < 0.01$), chewiness and hardness had a very significant positive correlation, with a correlation coefficient of 0.894 ($p < 0.01$), and a significant positive correlation with elasticity, with a correlation coefficient of 0.766 ($p < 0.05$), and a significant positive correlation between hardness and pH, and its correlation coefficient was -0.749 (p<0.05) It showed that colonies number and chewiness were two key factors that affected the storage quality of cattle upper brain. It can be seen that the correlation analysis between the indicators

showed that the information reflected by the measurement indicators overlaps. Therefore, it was necessary to perform principal component analysis on each quality indicator, which helped to improve the efficiency and accuracy of the comprehensive evaluation.

3.2 Principal Component Analysis of Quality Traits of Beef Upper Brain of Different Brands

The sensory, physical and chemical microbial indicators of three different brands of beef upper brain samples were measured, and SPSS software was used for principal component analysis. The number of principal components was determined according to the principle that the cumulative variance contribution rate reaches more than 85% and the eigenvalue was greater than 1^0. From Figure 1, Figure 2, and Table 3, we can seen that the first principal component was 3.688, the variance contribution was 40.978%; the second principal component was 2.969, the variance contribution was 32.993%; the third principal component was 1.07, and the variance contribution was 11.893%. The cumulative contribution rate of the third principal component had exceeded 85%. Therefore, it was feasible to use the first three principal components to evaluate the quality of beef upper brain of different brands. This showed that the first three principal components were sufficient to describe each index to represent the quality of beef brain meat, and the variance contribution rate of the principal components was used as the weighting coefficient to obtain the comprehensive evaluation function^0. The comprehensive evaluation function of beef upper brain quality was obtained: $K = 40.978\ K_1 + 32.993\ K_2 + 11.893\ K_3$, (K was the number of evaluation functions, K_1 was the main component 1, K_2 was the main component 2, and K_3 was the main component 3).

Table 3: Correlation matrix eigenvalues and cumulative contribution rate.

Ingredients	Initial eigenvalue			Extract the sum of squares and load		
	Eigenvalues	Variance%	Cumulative contribution Rate	Total	Variance%	Cumulative contribution Rate
1	3.688	40.978	40.978	3.688	40.978	40.978
2	2.969	32.993	73.971	2.969	32.993	73.971
3	1.07	11.893	85.863	1.07	11.893	85.863

Note: Extraction method-principal component analysis

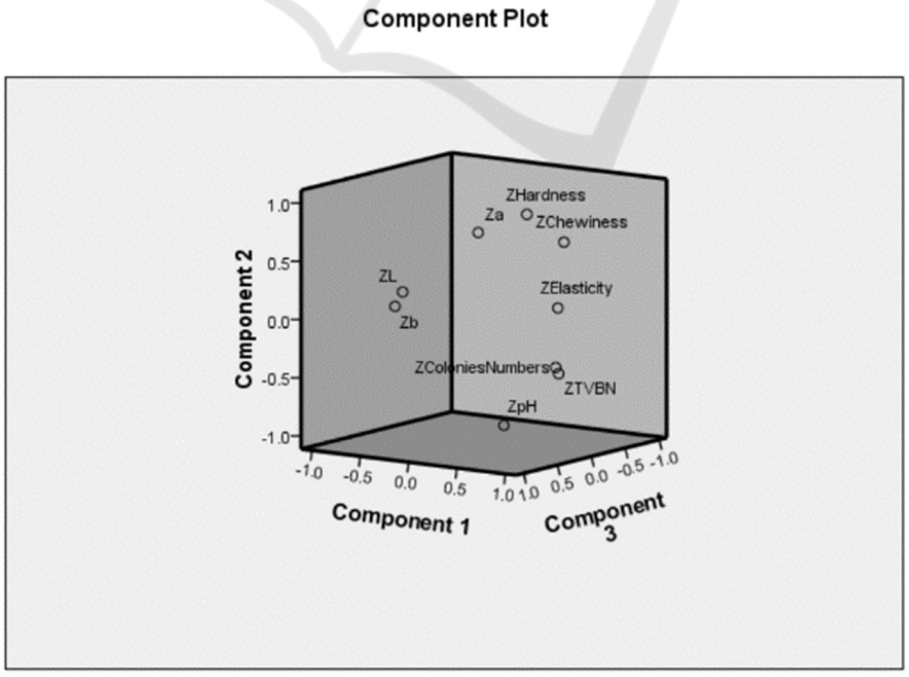

Figure 1: Component Plot.

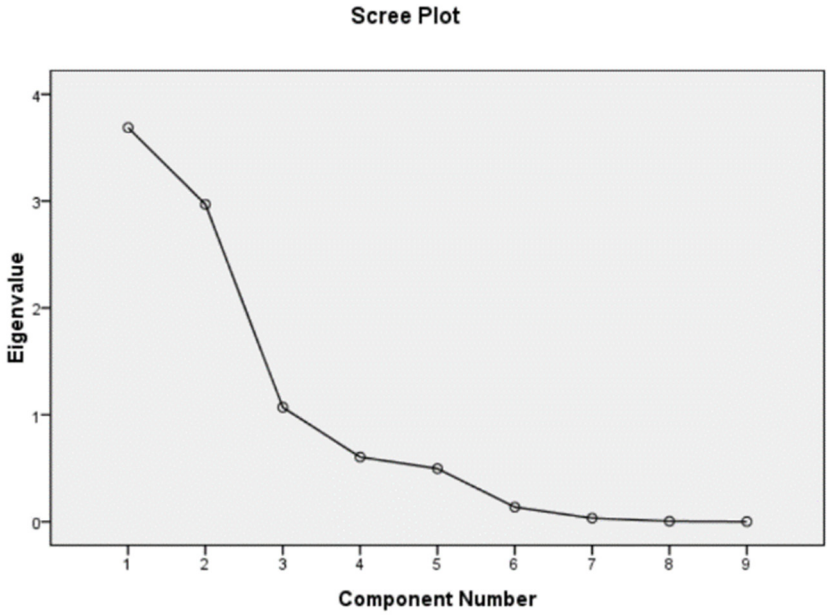

Figure 2: Scree Plot.

Table 4: Component loading matrix after principal component analysis rotation.

Serial number	variable	Ingredient		
		1	2	3
X1	L	-0.737	0.126	0.287
X2	a	0.093	0.729	0.195
X3	b	-0.174	0.178	0.888
X4	pH	0.279	-0.912	0.045
X5	TVBN value	0.781	-0.442	-0.007
X6	Colonies number	0.917	-0.342	0.125
X7	Hardness	0.394	0.885	-0.119
X8	Elasticity	0.935	0.175	0.074
X9	Chewiness	0.686	0.659	-0.253
X10	Senses	-0.694	-0.007	-0.544

Note: Extraction method-principal component analysis method. a. Three components have been extracted.

It can be seen from Table 4 that three principal components were obtained through principal component analysis, and the expressions of each principal component were:

$Z_1 = - 0.737\ X_1 + 0.093\ X_2 - 0.174\ X_3 + 0.297\ X_4 + 0.781\ X_5 + 0.917\ X_6 + 0.394\ X_7 + 0.935\ X_8 + 0.686X_9 - 0.694\ X_{10}$;

$Z_2 = 0.126\ X_1 + 0.729\ X_2 + 0.178\ X_3 - 0.912\ X_4 - 0.442\ X_5 + 0.342\ X_6 + 0.885\ X_7 + 0.175\ X_8 + 0.659\ X_9 - 0.007\ X_{10}$;

$Z3 = 0.287\ X_1 + 0.195\ X_2 + 0.888\ X_3 + 0.045\ X_4 - 0.007\ X_5 + 0.125\ X_6 - 0.119\ X_7 + 0.074\ X_8 - 0.253\ X_9 - 0.544\ X_{10}$;

The magnitude of the principal component factor load represented the contribution rate of the original variable in the comprehensive variable that was formed after dimensionality reduction. Therefore, the factor loading diagram can be used to determine the main original variables closely related to the principal components0. According to the absolute value of each index load, it can be seen that Z_1 mainly represents elasticity, colonies number, TVB-N value, L value, Z_2 mainly represents pH hardness and a value, and Z_3 mainly represents b value.

Table 5: Comprehensive scores and rankings of physical and chemical indicators of beef upper brain of different brands.

Brand	K	Sort
A	-0.133	2
B	1.06	1
C	-0.933	3

The comprehensive score and ranking of different brands of beef upper brains were calculated. The results were shown in Table 5. The higher the score, the better the quality of beef upper brain. The order of quality of different brands was as follows: B> A> C.

4 CONCLUSIONS

In this study, 10 quality indicators of 3 brands on the market were measured. Correlation analysis showed that the colonies number was significantly negatively correlated with sensory score and L value, and was extremely significantly positively correlated with TVB-N value and elasticity; Chewiness had a very significant positive correlation with hardness, a significant positive correlation with elasticity, and a significant positive correlation between hardness and pH. Further, through principal component analysis, the dimensionality reduction analysis of 10 indicators can be used to extract 3 principal components. The first principal component selected elasticity, colonies number, TVB-N value and L value; the second principal component selected pH, hardness and a value, and the third principal component selected b value. The cumulative variance contribution rate reached 85.863%, which can represent large some indicators, and built an evaluation model: $K = 40.978 K_1 + 32.993 K_2 + 11.893 K_3$. Using this model to rank the comprehensive quality of the selected three different brands of beef upper brains, the results showed that the best quality variety was brand B. Based on correlation analysis and principal component analysis, the comprehensive evaluation of different brands of beef upper brain quality can provide theoretical guidance for the evaluation of beef upper brain quality.

REFERENCES

Bai, J, Wang, H. (2020) Study on the preparation of onion extract/PVA film and its effect on the quality of chilled meat. Packaging Engineering, 41(05): 103-108.

Guo, L. Cai, LS. Lin, Z. et al. (2010) Construction of white tea aroma quality evaluation model based on principal component analysis. Journal of Tropical Crops, 31(9): 1606-1610.

Liang, L. Du, ARN. Ma, Tao. et al. (2018) Optimization of pretreatment technology of low-salt cowpea kimchi and analysis of storage characteristics. Food science, 39(06): 246-251.

Liu, JM. Lin, LJ. Liu, YJ. et al. (2021) Comprehensive Evaluation of Dry Quality of Different Varieties of Longan Based on Principal Component Analysis. Preservation and processing, 21(05) : 127-133.

Liu, Q. (2019) Study on the fresh-keeping effect of cumin, prickly ashand cinnamon essential oil soncold-fresh lamb. Gansu Agricultural University.

Mao, Yt. (2017) Research on Governance of Pig Supply Chain from the Perspective of Quality. Southwest Jiao tong University.

National Health and Family Planning Commission of the People's Republic of China. GB4789.2-2010, (2017) Determination of the total number of bacterial colonies in food microbiology examination. Beijing: China Standards Press.

National Health and Family Planning Commission of the People's Republic of China. GB5009.228-2016, (2017) Determination of Volatile Basic Nitrogen in Food. Beijing: China Standard Press.

Wang, H. Chen, L. Chen, K. et al. (2007) Multi-index comprehensive evaluation method and choice of weight coefficient. Journal of Guangdong College of Pharmacy, 23(5): 583-589.

Wang, JJ. Qiao, Q. Ma, LE. et al. (2004) The metabolic syndrome defined by factor analysis and incident type 2 diabetes in a Chinese population with high postprandial glucose. Diabe-tes Care, 27:2429-2437.

Wang, P. He, Bb. Li, Zc. et al. (2019) The effect of biological preservatives on the preservation of chilled meat. Chinese Journal of Food Science and Technology, 19(11) : 199-207.

Wu, D. Li, X. (2019) Microbial Contamination and Preventive Measures in the Process of Chilled Fresh Meat Preservation. Food Industry Science and Technology, 40(21): 320-325.

Xu, H. Hao, LZ. Liu, SJ. et al. (2020) Comparison and analysis of nutritional quality of eliminated female yak meat in different regions. Food Industry Technology, 41(09): 232-237.

Yang, WT. Li, JL. Kong, F. et al. (2017) Construction of Frozen Tan Mutton Quality Evaluation Model Based on Principal Component Analysis. Food Industry Technology, 38(09): 300-303+313.

Zhao, J. Zhang, T. Liu, Yf. et al. (2018) The effect of long freezing time on beef quality. Food and Fermentation Industry, 44(11): 200-209; 215.