



Analysis and Evaluation of Nutrition and Safety Indicators of Four Types of Dog Food

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Abstract. This study analyzes the nutritional composition, physicochemical and safety indicators of four dog foods on the market. The results showed that dog food generally had problems such as low protein content, rich fat content and high energy. Physical and chemical indicators showed that the freshness of dog food was good, but the nitrite content of large dog food was high. Analysis of biogenic amines and nitrosamines has shown that puppy food contains high levels of these substances and may affect pet health.

Keywords. dog food; nutritional indicators; physical and chemical indicators

1 Introduction

The domestic pet market is growing rapidly, and the pet food market is expected to reach RMB241.7 billion by 2025[1]. At present, compared with foreign developed countries such as the United States, domestic pet food standards are not comprehensive and reasonably low. The U.S. dog food standard specifies 37 nutrients [2], while China's current National Standard of the People's Republic of China (GB/T31216-2014) [3] only stipulates 8 of these nutrient indicators. In terms of nutritional personalization, the nutritional needs of dogs of different sizes, species, and health conditions cannot be met [4][5] [6].

In terms of safety indicators, biogenic amines are an important indicator to evaluate the freshness and safety of food. Small amounts of biogenic amines are beneficial for pets, while excessive intake can cause toxicity [7]. The determination and safety evaluation of biogenic amine content in pet food such as dog food are relatively few domestic research reports. Tian Ying [8] and Zhou Lingyu [9] studied the detection method of biogenic amines in animal feed and aquatic products. Zhao et al. [10] studied the influence and formation mechanism of biogenic amines in different packaging methods of pork.

This paper selects four kinds of dog food on the market, and systematically analyzes their nutritional composition, physicochemical and safety indicators, hoping to help manufacturers improve product quality and provide consumers with a reference for purchase.

2 Experimental materials and equipment

2.1 Experimental materials

Experimental dog food: adult small dog and lamb dry food (A), sensitive skin and gastrointestinal dog food (B), puppy chicken and oat food (C), adult large dog all-natural chicken (D).

Chemical reagents: Mixed standards of nine volatile N-nitrosamines: NDMA, NMEA, NDEA, NDPA, NDBA, NPIP, NPYR, NMOR, NDPheA; Eight biogenic amine mixed standards: TRY, PHE, PUT, CAD, HIS, TYR, SPD, SPM; Zinc acetate, silver nitrate, p-aminobenzene sulfonic acid, thiobarbituric acid, etc.

Instruments & Equipment: Agilent 7890A Gas Chromatograph, Agilent 1200 High Performance Liquid Chromatograph (Agilent Technologies), TU-1800 External Spectrophotometer ((Shimadzu)), UDK159 Semi-Micro Kjeldahl Nitrogen Meter (Velp), T 18 Basic Homogenizer (IKA), PB-10 pH Meter (Sartorius), RE-2000A Rotary Evaporator, SHZ-III. circulating water vacuum pump (Shanghai Yarong Biochemical Instrument Factory), N/A solid phase extraction cartridge device (Supelco), etc.

2.2 Standard and Methods

According to the national standard GB 5009-2016 series of standard methods, the nutritional, physicochemical and safety index testing of dog food was carried out.

3 Test results and analysis

3.1 Measurement results and analysis of nutritional indicators

Table 1. Nutrient content indexes of four types of dog foods

| sample | protein /% | fat /% | water content /% /% | ashy substance | energy |
|--------|------------|------------|---------------------|----------------|---------|
| A | 9.80±0.14 | 2.74±0.18 | 63.59±1.69 | 2.08±0.01 | 543.89 |
| B | 10.72±0.22 | 10.91±0.30 | 60.38±1.06 | 2.46±0.25 | 880.18 |
| C | 10.62±0.18 | 6.86±0.22 | 58.50±0.44 | 2.26±0.33 | 700.92 |
| D | 10.89±0.34 | 18.69±0.67 | 45.60±2.38 | 2.68±0.39 | 1087.46 |

The protein in dog food is used to support muscle growth and stamina maintenance in dogs. As can be seen from Table 1, the protein content of the four dog foods is about 10%, which is lower than the national standard GB/T 31216-2014 stipulates that the crude protein content of adult dog food is $\geq 18\%$, and the puppy dog food is $\geq 22\%$, which is a low-protein dog food. Market research has found that [5] the higher the crude protein content, the higher the price of the product. These four dog foods should be low-cost pet food. Fat is an important source of energy for pets, and it is especially critical for the health of your pet's coat. The fat content of different dog foods varies significantly. The fat content of large dog food (18.69%) is 6.8 times that of small dog

food (2.74%), and the fat content of adult dog food (18.69%) is 2.7 times that of young dog food (6.86%). The fat content of specific dog food B for skin and gastrointestinal sensitivities is the average of the fat content of large and small dog foods (10.91%). It is different from the crude fat content of adult dog food $\geq 5\%$ and puppy dog food $\geq 8\%$ required by the national standard GB/T 31216~2014. The higher the crude fat content of pet food, the higher the product price is also relatively high [5]. Water is an important part of pet wet food, suitable for different dogs dog food water content has a certain gap, puppies, puppies and other water content is relatively high at about 60%, belongs to wet dog food, they are more conducive to small, puppy food; The water content of adult dog food is relatively low at about 45%, which is a semi-wet dog food. The ash content mainly reflects the content of inorganic salts and minerals in the food, and the ash content of the four dog foods is not much different, all of which are about 2%. Adult large dog food has the highest energy (1087.46 kJ/100g), and its high fat and moderate protein ratio is suitable for large dogs with high energy needs. The energy of small dog food is relatively low (543.89kJ/100g), which is only half of that of large dog food.

3.2 Measurement results and analysis of physical and chemical indexes

Table 2. Determination of physical and chemical indexes of four types of dog food

| sample | nitrite / (mg/kg) | TBARs/(mg/kg) | pH | NaCl/% |
|--------|-------------------|---------------|-----------|-----------|
| A | 11.37±0.65 | 0.85±0.8 | 6.92±0.06 | 1.63±0.23 |
| B | 11.28±0.94 | 0.92±0.08 | 6.91±0.23 | 1.34±0.12 |
| C | 16.10±1.13 | 0.87±0.05 | 7.14±0.21 | 2.26±0.21 |
| D | 21.47±1.19 | 0.82±0.03 | 6.36±0.03 | 1.37±0.04 |

It can be seen from Table 2 that the nitrite content of the four dog foods is 11~21 mg/kg, and the nitrite content of adult large dog food is too high (21.47 mg/kg), which may be due to the use of too many processed meat ingredients. TBARs (thio-barbituric acid reactants) represent the levels of MDA (malondialdehyde), the main lipid oxidation product, as well as some minor related compounds, which are one of the causes of spoilage of meat. The TBARs content of the above four dog foods was relatively low (less than 1 mg/kg) and the freshness was relatively good. The pH of the four dog foods is close to neutral, with the puppy food having the highest pH (7.14), the weakly alkaline food is more suitable for the digestive system of young pets, the pH of the adult dog food is 6.92, 6.91 and 6.36, and the weakly acidic food is more suitable for the gastrointestinal tract of adult dogs. Another whole dog food on the market has a pH as low as 5.85, which is more suitable for pets that require specific acidity foods. The salt content of the four dog foods is 1.3~2.3%, among which the

salt content of puppy food is relatively high (2.26%), and the intake needs to be controlled when feeding.

3.3 Determination and analysis of biogenic amine content

Table 3. Determination of biogenic amine content in four dog foods (mg/kg)

| sample | TRY | PHE | PUT | CAD | HIS |
|--------|------------|-----------|-----------|------------|-----------|
| A | 2.92±0.07 | | 0.56±0.05 | - | |
| B | 8.78±0.15 | | | | 0.35±0.06 |
| C | 15.77±0.15 | 2.03±0.06 | - | 10.79±0.05 | 2.66±0.06 |
| D | - | 6.12±0.12 | - | - | 1.41±0.06 |

| sample | TYR | SPD | SPM | TBA | BAI |
|--------|-----------|-----------|-----------|------------|------------|
| A | | | - | 3.48±0.12 | 0.56±0.05 |
| B | 8.23±0.06 | 0.48±0.03 | | 17.84±0.18 | 8.58±0.06 |
| C | 6.53±0.05 | 1.29±0.05 | 1.47±0.04 | 40.54±0.14 | 19.98±0.06 |
| D | 0.89±0.10 | 1.54±0.12 | - | 9.96±0.06 | 2.30±0.10 |

Note: Not detected

Table 3 shows the biogenic amine levels in four dog foods, including tryptophan, phenylethylamine, putrescine, cadaverine, histamine, tyramine, spermidine, spermine, total biogenic amine (TBA), and biogenic amine index (BAI). Biogenic amines are chemicals formed during the decomposition of food proteins, and their content can be used as an important indicator to evaluate the freshness and safety of food. Small amounts of biogenic amines are beneficial for pets, and excessive intake can cause poisoning. There are differences in the biogenic amine content of the four dog foods. The C biogenic amine index of puppy food reached the highest value of 19.98, and the total biogenic amine content also reached a high value of 40.54 mg/kg, which may be the result of microbial contamination during storage or handling, which caused significant protein decomposition. The total biogenic amine content of adult small dog food A was low (3.48 mg/kg) and the biogenic amine index was also low (0.56), indicating that the biogenic amine content was effectively controlled and the safety of pet food was improved.

3.4 BAI Multiple comparisons and analyses of averages

Table 4 shows the difference between the BAI values of each sample and the lowest BAI value (0.00) and the BAI values of other samples, marked with an asterisk (** for $p < 0.01$ and * for $p < 0.05$). Puppy food C showed the highest BAI value (19.98), which means that the concentration of biogenic amines in this food was significantly higher than that of all other samples, and the difference in BAI values from other samples reached extremely significant levels ($p < 0.01$), indicating that there may be contamination during storage or handling, or that the raw material used contains biogenic amines with higher levels than normal. The BAI value of adult large dog food D was lower (2.30), indicating that it performed better in biogenic amine control. High

BAI values indicate poor biogenic amine control and require manufacturers to focus on raw material selection, production process control, and product storage conditions to reduce the risk of high biogenic amine levels. For pet owners, it is more desirable to choose products with low BAI values, especially in pets that are sensitive to biogenic amines.

Table 4. Multiple comparisons of BAI averages for four dog foods

| sample | BAI | xij-0.00 | xij-0.56 | xij-2.30 | xij-2.69 | xij-4.12 |
|--------|------|----------|----------|----------|----------|----------|
| A | 0.56 | 0.56 | | | | |
| B | 4.12 | 4.12** | 3.56** | 1.82** | 1.43** | |
| C | 19.9 | 19.98* | 19.42* | 17.68* | 17.29** | 15.86* |
| D | 2.3 | 2.30** | 1.74** | | | |

| sample | xij-4.55 | xij-7.48 | xij-8.01 | xij-8.43 | xij-8.58 | xij-9.32 |
|--------|----------|----------|----------|----------|----------|----------|
| A | | | | | | |
| B | 15.43** | 12.50** | 11.97** | 11.55** | 11.40** | 11.3 |
| C | | | | | | 10.66** |
| D | | | | | | 7** |

3.5 Determination and analysis of nitrosamine content

Table 5. Determination of nitrosamine content in four types of dog food (µg/kg)

| sample | NDMA | NMEA | NDEA | NDPA | NDBA/ NPIP |
|--------|------|-----------|------|-----------|------------|
| A | - | - | - | 0.58±0.04 | 9.17±0.03 |
| B | - | - | - | 0.97±0.06 | 5.04±0.04 |
| C | - | - | - | 0.52±0.04 | 14.91±0.04 |
| D | - | 0.18±0.04 | - | 5.01±0.05 | 1.34±0.05 |

| sample | NPYR | NMOR | NDPheA | Total nitrosamines |
|--------|------|-----------|-----------|--------------------|
| A | - | 0.24±0.05 | - | 9.99 |
| B | - | - | - | 6.01 |
| C | - | - | - | 15.43 |
| D | - | - | 2.66±0.10 | 9.19 |

Note:- Not detected

Nitrosamines are known to be potential carcinogens and often come from food processing, and monitoring their levels is essential to ensure pet food safety. As can be seen from Table 5, the content of certain types of nitrosamines in different dog diets is more prominent. The NDBA/NPIP content accounted for the largest proportion of the total nitrosamines. The NDBA/NPIP content in puppy food C was as high as 14.91 $\mu\text{g}/\text{kg}$, resulting in a high total nitrosamine content of 15.43 $\mu\text{g}/\text{kg}$. Pet food manufacturers should pay attention to optimizing processing conditions to reduce the formation of these harmful substances.

4 Conclusion

This study analysed the nutritional content and safety indicators of four dog foods and found that the protein content was generally low, while the fat content and energy content were high. Physical and chemical indicators showed that the freshness of dog food was good, but the nitrite content of large dog food was high. Analysis of biogenic amines and nitrosamines showed that puppy food was high in these substances. It is recommended that pet owners consider factors such as nutritional content, physical and chemical indicators, biogenic amine and nitrosamine content when choosing dog food, and manufacturers should optimize the selection of raw materials and production processes to ensure that the dog food produced is both nutritious and safe.

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