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Original article

Measurement of the physicochemical, performance, and consumer-information characteristics of commercial nonmedicated shampoo for dogs

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Abstract

The aim was to analyze the quality of commercial shampoo without prophylactic effect for dogs. The analysis was based on the evaluations and requirements established for human-line products since there is no guide for veterinary products in Mexico; such evaluations have not been carried out or published in Mexico. Physicochemical, sensory, performance, and consumer information tests of the shampoo were carried out. The sample consisted of twenty products marketed in Mexico City. During the evaluation of the label, a serious non-compliance with applicable regulations was found. The pH of the products ranged between 5.6 and 8.4; Significant differences ($p<0.05$) were found between the three groups with low (6.1), medium (7.2), and high (8.1) pH. Viscosity values were from 1131 to 3102. For the foam index, no statistically significant differences were found. 100% of the products analyzed complied with the rest of the quality tests carried out. The results of the quality analysis in this study will allow veterinarians specializing in small species to better select and recommend the products for their use and inform dog owners, about the safety, and value of the products.

Key words: veterinary shampoo, quality control, sensory evaluation, performance evaluation, label, animal welfare, dog bath

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Introduction

Companion animals worldwide are increasingly considered an important part of the family, which is why they are provided with a better quality of life. A clean dog has a positive effect on emotional well--being, which is reflected in people's health, especially those whose only companion is their dog. To our knowledge, there are no official censuses or statistical estimates of the population of dogs and cats in Mexico. However, based on official data (INEGI 2014), the density of dogs in CDMX is expected to be 1,438.66 (dogs/km^2) in 2021, for a total of 38.4 million domiciled dogs. The pet industry generates employment and economic growth as it includes a wide variety of accessories for pets and a wide range of hygiene products, such as shampoo. These hygiene products are not currently regulated like their human counterparts, where processing companies are fined if they fail to comply with claims or falsely advertise properties.

Dog skin

The skin is an anatomical and physiological barrier between the body and the environment; it protects animals from physical, chemical, and microbiological damage (Miller et al. 2013, Ríos et al. 2015). Dog skin is anatomically and physiologically different to human skin; it is less acidic and thinner, it lacks sweat glands across much of the body except for the footpads, and it has a higher density of hair follicles than human skin (Oliveira et al. 2015). The pH influences the permeability of the skin barrier and normal keratinization processes. The pH value of canine skin differs from that of humans and tends to be higher than that of most other mammalian species. According to Proksch (2018), the average pH value in humans is 4.1-5.8; unlike dogs, where the pH is more basic, it is between 6 and 7. In addition, the pH of the skin fluctuates according to the area of the body (Szczepanik et al. 2011, 2012).

Shampoo and its physicochemical characteristics

The shampoos and soaps used by humans are designed according to the typical pH of the human skin. For this reason, if one of these products is used in another species, such as a dog, it can cause a skin imbalance, making the skin more susceptible to harmful agents found in the environment (Yang 2017). The function of the shampoo is to clean dirt and remove detached hair, excess oil, and accumulated particles, which maintains the anatomical structure and prevents dry skin and hair. Healthy hair has a hydrophobic surface to which lipids adhere and repels water. When shampoo is applied to damp hair, it is adsorbed on the surface between the hair and the sebum. Anionic surfactants reduce surface tension and promote the removal of sebum from the hair. The fatty matter (apolar) is emulsified with shampoo and water and is removed with rinsing (Yang 2017).

The shampoo is expected to form abundant foam, be easy to rinse, have a suitable pH for the intended species, have adequate viscosity, and not be irritating to the eyes. The viscosity of the shampoo affects its performance since it should not run between the fingers of the person who is bathing the dog or the dog's hair during washing. The shampoo application should be simple and not hindered by being dispensed from its container (Krunali et. al. 2013). Quality measurements have already been carried out on hygiene and beauty products for human use (PROFECO 2009, Rigon et al. 2013) and for pet products in Venezuela (Dlujnewsky and De Aguilar 2014); however, quality measurements of pet products have not been carried out in Mexico. Therefore, to ensure the quality of shampoo for pets marketed in Mexico City and the surrounding area, a comparative analysis of pet shampoos was carried out in this study.

Regulatory status of shampoo

In Mexico, chemical products for hygiene and beauty have been exempt from regulation by the SADER / / SENASICA Secretariat since August 14, 2018. At this time, an agreement by the Federal Official Gazette was published, which modified a similar agreement in which it specified that nonmedicated products for animal use or consumption were deregulated. As cited in article 3 of the agreement.(SENASICA, 2018) However, these products are not exempt from complying with other applicable regulations.

Materials and Methods

The present study examines the quality of 20 nonmedicated shampoos for companion animals that are sold in Mexico City (CDMX) and a suburban area. The products were investigated through analysis of their physicochemical and sensory characteristics, performance tests and compliance with current regulations, including the information available on the product label (NOM-059-ZOO-1997, NOM-012-ZOO-1993).

I - Physicochemical Tests

Physical appearance. Sensory test. Based on visual observation of the samples, compliance with the following general conditions was verified. (PROFECO 2009, Rigon et. al. 2013)

- Appearance.

Transparent liquids must be free of any sediment or particles. Products in emulsion, dispersion, or suspension form must be utterly homogeneous without visible separation signs. Other evaluated parameters were a color, homogeneous or heterogeneous, and smell as pleasant or unpleasant.

II - Determination of pH

A Mettler Toledo potentiometer kit was used. The use of and calibration procedures for the kit were carried out according to the manufacturer's instructions and according to the MGA0701 procedure (FEUM 2011). For shampoo products, a 1:10 dilution was made with double distilled water at pH 7. The pH was measured when the samples were at 25°C±2. Calibration liquids of pH 4.01, pH 7.00 and pH 12 were used, all with the specified pH±0.01 at 25°C (77°F). Three measurements were made for each product.

III - Determination of viscosity

A Brookfield viscometer, model DV-II-trv, was used. Viscosity was measured according to MGA 0951 (FEUM 2011) using a No. 4 to 6 needle. Measurements were performed in triplicate in 100 mL of product at a speed of 12 rpm.

IV - Determination of Relative Density

Relative density determination was carried out according to MGA 0251 (FEUM 2011). A pycnometer and balance (OHAUS® Pioneer with an analytical precision of 0.0001 g) were used. The process was carried out in triplicate. The entire process was conducted at 20°C. The densities were obtained using the formula: ρ=m1/m2(ρ2)ρ1: density of the sample contained in the pycnometer; m1: mass of sample contained in pycnometer (g); m2: mass of distilled water (or liquid of known density) contained (g); ρ2: density of water (or liquid of known density) contained in the pycnometer.

V - Determination of solubility

One milliliter of shampoo and 10 mL of deionized water were added to a beaker and stirred with a glass rod. The solubility was classified through sensory observation (Alquadeib et al. 2018).

VI - Laboratory performance tests

- Foam Index

One milliliter of distilled water and 1 mL of the shampoo sample to be tested were placed in a 10 mL test tube. The tube was closed with its cap, and during stirring, the tube was placed at an angle of inclination of approximately 70 degrees. The tube was shaken for 1.5 to 2 minutes. The beginning of the foam to the end of the foam was measured with a ruler. If the surface of the foam was not perpendicular to the tube, an imaginary line to the most linear part was used for the measurement. The measurement was repeated at 1, 3, and 5 minutes after shaking (Ahad *et al*. 2013). The results were obtained using the formula:

Foam index = foam height / total height

- Foam quality

Five milliliters of 1% shampoo solution were placed in a 10 mL test tube and covered with parafilm. The test tube was inverted 10 times at 180°C. The total height and the foam height were measured at 0, 3, 5 and 10 minutes. The shape of the bubbles was observed and noted. The foam was considered to be of better quality if had a closed structure (there was no space between bubbles), was longer lasting and could be easily rinsed. A durable foam had relatively constant foam rates, and if it had an open structure, the space between each bubble was wider. If the space between each bubble was almost zero, the foam was said to be a creamy or closed foam (Budreckiene et al. 2016).

- Detergency

5 grams of woolen cloth were placed in 100 mL of water containing fat (20 mL of a 25% lanolin solution); the cloth was then placed in a 600 mL flask containing distilled water with 10 mL of shampoo and shaken for 2 minutes at a rate of 50 times per minute. The fabric was dried and weighed. The amount of fat removed was calculated using the following equation: DP=100(1-/C), where DP is the percentage of detergent power, C is the weight of tallow in the control sample, and T is the weight of tallow in the test sample (Budreckiene et al. 2016).

- Untangling

The test was carried out with several strands of natural hair to which the selected products were applied. Special attention was paid to ease of combing and detangling for both wet and dry hair. The performance of the product was also rated in terms of wetting, silkiness, body, volume, gloss etc. (PROFECO 2009).

- Clearance

The test was carried out with several strands of natural hair to which the selected products were applied. Special attention was paid to the ease of rinsing of the shampoo (PROFECO 2009).

Table 1. Determination of pH, viscosity, and relative density of nonmedicated dog shampoos.

Shampoo ID	pH		Viscosity (mPa-s)		Relative density (g/mL)	
	Mean	SD±	Mean	SD±	Mean	SD±
1*	5.6	0.09	2396	0.6	1.002	0.002
2*	6.0	0.08	2962	2.1	1.053	0.004
3*	6.8	0.14	1581	1.7	1.083	0.002
4**	7.1	0.06	1696	3.2	1.042	0.003
5**	7.0	0.01	3102	1.5	1.042	0.003
6**	7.8	0.04	1136	3.0	1.087	0.003
7**	7.9	0.08	2308	1.5	1.003	0.001
8**	7.0	0.17	2275	2.1	1.007	0.003
9**	7.5	0.06	1132	1.0	1.006	0.004
10**	7.1	0.11	2274	2.5	1.022	0.016
11**	7.0	0.39	1134	1.5	1.047	0.003
12**	7.6	0.00	1268	1.0	1.099	0.006
13**	7.0	0.15	2176	1.0	1.003	0.003
14**	7.2	0.02	1136	1.5	1.004	0.001
15***	7.6	0.14	2803	3.1	1.037	0.006
16***	8.1	0.10	2774	1.5	1.045	0.017
17***	8.2	0.09	1139	1.7	1.043	0.009
18***	8.2	0.08	1137	2.1	1.022	0.008
19***	8.3	0.13	1131	1.0	1.003	0.001
20***	8.4	0.18	1629	1.0	1.008	0.001

In the pH and viscosity tests, significant differences ($p<0.05$) were found between the three groups of low pH *, mean pH ** and high pH ***. There were no significant differences in relative density among the three groups.

VIII - Available information on the label for the user

The properties listed on the label of each product were analyzed for veracity and compliance with all the information required by the Official Journal of the Federation.

Statistical analysis

To determine whether there were statistically significant differences in the variables, the 20 shampoos were grouped according to their averages by a unit of pH into the following groups: 5.5-6.6 (low pH, shampoo 1, 2, and 3); 6.7-7.6 (medium pH, shampoo 4, 5, 8, 9, 10, 11, 12, 13, 14, and 15), and 7.7-8.6 (high pH, shampoo 6, 7, 16, 17, 18, and 20). Kruskal Wallis analysis and post-hoc Dunnet tests with Bonferroni correction were performed with $p<0.05$ in PAST 4.03 software, Øyvind Hammer, Natural History Museum, University of Oslo [ohammer (at) nhm.uio. no]. The same groups and the same analysis was used to evaluate viscosity, foam index and relative density.

Results

For the sensory tests that evaluated appearance, aroma and color, all the samples met the requirements. No sample presented residue, sediment or foreign particles, and all showed a phase and were completely uniform. Regarding color, all the samples were homogenous and pleasant to the eye. Regarding aroma, all the samples were pleasant smelling according to the researcher's assessment.

For determination of the content and solubility, detergency test, detangling and in vitro lightening of the shampoos analyzed, all the evaluated products passed these tests.

Table 1 shows the determination of pH, viscosity, and relative density of nonmedicated dog shampoos. Significant differences ($p<0.05$) were found among the three pH groups of low pH (6.1±0.14, mean±SE), medium pH (7.2±0.05 mean±SE), and high pH (8.1±0.04 mean±SE). Differences were also observed

Table 2. Index and quality of the foam of nonmedicated dog shampoos.

Shampoo ID	Foam index (minutes)					Foam quality	
	0	3	5	Mean	SD±	Open	Closed
1*	3	3.4	3.3	3.0	0.5		•
2*	3.5	2.7	2.5	2.9	0.5		•
3*	2.5	2.7	2.2	2.5	0.3		•
4**	2	3	2.2	2.4	0.5		•
5**	3	3	3	3.0	0.0		•
6**	2.5	3	3	2.8	0.3		•
7**	3	2	2	2.3	0.6	•	-
8**	2.5	3	2.7	2.7	0.3		•
9**	3	3.2	2.9	3.0	0.2		•
10**	2.5	2.7	2.5	2.6	0.1		•
11**	3.5	4	4	3.8	0.3		•
12**	2.8	3.5	3.5	3.3	0.4		•
13**	2.5	3.5	3.4	3.1	0.6		•
14**	3	2.5	2.5	2.7	0.3		•
15***	3	3.5	3	3.2	0.3		•
16***	3	3.5	3.4	3.3	0.3		•
17***	2.5	2.7	2.8	2.7	0.2		•
18***	3	3.5	3.5	3.3	0.3		•
19***	2.3	3.2	3	2.8	0.5		•
20***	2.5	3.1	2.9	2.8	0.3		•

There were no statistical differences between the three groups of low pH *, mean pH ** and high pH ***.

in the viscosity of the shampoos between the low pH group (2511±117 mean±SE) and the medium pH group (1840±129 mean ± SE) and the high pH group (1608±140 mean±SE). No difference was found between the medium pH and high pH groups. Additionally, no significant differences were found in relative density among the three groups, which presented a mean of 1.0 and SEs of 0.008, 0.005, and 0.006 for the low, medium, and high groups, respectively (Table 1).

Table 2 shows the index and quality of the foam of nonmedicated dog shampoos. For the foam index, no statistically significant differences were found among the low, medium, and high groups, which had values of 3±0.15, 2.9±0.08, and 2.8±0.09 mean±SE, respectively (Table 2).

Table 3 shows information obtained from the label of the hygiene and beauty products analyzed.

Discussion

This study presents an overview of the quality of non-drug pet shampoos sold in Mexico City and neighboring areas. This research was carried out because an evaluation of these products has not been published in Mexico, unlike other countries such as Venezuela, where some quality evaluation tests have been carried out and disclosed. The situation is different in Mexico for human shampoo. The quality control of human shampoo is evaluated by organizations such as the Federal Consumer Prosecutor's Office (PROFECO 2009). Quality tests are conducted on products sold in Mexico. The results are published in print or digital form (in consumer magazines) to inform consumers of quality and performance results to help them select products for personal use.

One of the physicochemical characteristics measured is pH. According to the literature, shampoos for small species must have a value adapted for or respectful of canine skin; according to Young et al. (2002), the pH can be between 5.5 and 8.5, depending on the area the body. All the shampoos evaluated fell within these values for use in dogs in the present study. However, other authors reported that the skin pH varies according to the breed of dog. Products with values from 5.6 to 6.8 are better suited to the Springer Spaniel breed, and those with a pH of 8 to 8.4 are better suited to the Siberian Husky and Manchester Terrier breeds (Matousek and Campbell 2002, Young et al. 2002). The pH of shampoos is important for minimizing eye irritation, and stabilizing the ecological balance of the scalp, which is why shampoos are currently encouraged

Table 3. Information obtained from the label of dog shampoos.

ID	Name	Lt	Ex	C / o	I / u	Uw	Lvu	Lang	Compliance (%)
1	Guau	•	•	MX	•	•	•	•	100
2	Bath&Kan	•	NC	IMP	•	•	•	• Bl	86
3	Shower Time	•	•	MX	•	•	•	•	100
4	Shower Time cachorros	•	•	MX	•	•	•	•	100
5	Animal Planet	•	•	MX	•	•	•	•	100
6	Tornado	•	•	MX	•	•	•	• Bd	100
7	Hartz	•	NC	USA IMP	•	•	NC	Eng NC	63
8	Ultra Clean	NC	NC	MX	•	•	•	•	71
9	Ozzy	•	•	MX	•	•	•	• Bd	100
10	Oster	•	NC	USA IMP	•	NC	NC	• Bl	63
11	Pelo dorado	•	•	MX	•	NC	•	•	86
12	Pelo negro	•	•	MX	•	NC	•	•	86
13	Ruimi	•	•	MX	•	•	•	•	100
14	Respet	•	NC	MX	•	•	NC	•	71
15	Cuidado especial Pug	NC	NC	MX	•	•	•	•	71
16	Ddyko	•	•	MX	•	•	•	•	100
17	Nogal	•	•	MX	•	•	•	•	100
18	Avena Natural	•	•	MX	•	•	•	•	100
19	Magic Coat	•	NC	USA	•	•	NC	Eng NC	63
20	Normakan	•	•	MX	•	•	•	•	100
Compliance (%)		90 %	65	100	100	85	80	90	88

Id = Identification; Lt = Lot; Ex = Expiration; C / o = Country of origin; I / u = Indications for use; Uw = Usage warnings; Lvu Legend: Veterinary use; Lang= Language; IMP = import; USA = United States of America; MX = Mexico; Bl= Bilingual; Bd=Biodegradable; Eng= English; NC = does not comply; • = complies

to have a pH commensurate with the skin pH of the species in question to minimize damage to the hair, prevent swelling, promote tightening of the hair scales, and induce shine (Ahad et al. 2013). Veterinary shampoos must be specifically designed for the targeted species, taking into account anatomical and physiological differences. These differences include the thickness of the stratum corneum (finer), the pH of the skin (relatively more alkaline), and the density of the hair follicles (higher), which can facilitate skin penetration of the active ingredients. On the other hand, Miller et al. (2013) found that not all the products they evaluated complied with the pH of all dog breeds. Shampoos were found that had pH values >8.3, while others had values of 5 or 6. These ph values agree with those reported by Budreckiene et al. (2016), who found values from 5.5 to 8.73. This finding corroborates the present findings.

Due to the role of pH in the skin's barrier function, shampoos used on canines should not cause an imbalance in the skin, increasing the skin's susceptibility to harmful agents found in the environment. Ríos et al. (2015) reported that the skin's microflora is influenced by the pH, temperature, and grooming of the dog. In healthy dogs, S. pseudintermedius is part of the skin microflora. It colonizes the skin, hair, and especially mucocutaneous junctions, such as the nose, mouth, and anus. It is also an opportunistic pathogen and constitutes 90% of Staphylococcus isolated from healthy carriers and dogs with skin problems. Although S. pseudintermedius does not regularly colonize humans, transmission between dog and owner is possible. It has recently been described in several studies indicating that it can pose a health risk. For this reason, it is important to treat companion animals, especially due to the rapid and recent emergence of methicillin-resistant

strains of S. pseudintermedius (SPRM) (Budreckiene et. al. 2016).

The viscosity of the shampoos is an important characteristic that facilitates their extension on the hair. The viscosity of a liquid is not always constant, and is usually related to other variables, such as temperature (higher temperature, greater fluidity; lower temperature, more viscous) (Ahad et al. 2013). Viscosity is a process test, and the product manufacturer determines the viscosity value according to their specifications. All the veterinary shampoos evaluated were within the ranges published by Budreckiene et al. 2016, where values ≥ 3429 as high viscosity, ≥ 2710 as mean value, and <92.5 as low viscosity are considered. In the present study, only one shampoo had a viscosity value > 3000, 8/20 products had values > 2000, and 11/20 had a value of > 1000. However, even the highest viscosity value did not present difficulty rubbing or friction in the hair.

In the case of the values =1000, the shampoo did not present problems in any of the following aspects: being too liquid, increasing the amount of shampoo required during the bath (detergency), product runoff between the fingers, and greater use of water for rinsing, which leads to further environmental pollution.

Although there is no officially established value or interval, the relative density should be as close as possible to the value of water =1, which would lead to no difference between the density of water and the shampoo. A relative density close to one allows for the rapid and complete rinsing of the product. All the products evaluated complied with this aspect (Budreckiene et al. 2016).

Shampoo performance tests were carried out in the laboratory (in vitro) with several strands of natural hair applied to the evaluated products. Special attention was paid to the ease of hair brushing on both wet and dry hair. In addition to shine, the product's performance was rated in terms of wetting, silkiness, body, volume, and hair restoration. All the evaluated products met these tests. The evaluation also assessed foaming, lightening, and detangling, and all the evaluated products passed these tests. Other characteristics that were evaluated were as follows:

Detergency

All the evaluated shampoos complied with the requirements of removing dirt, eliminating dust and grease particles, reducing surface tension, and rinsing clean (Budreckiene et al. 2016).

Foaming ability and foam stability

Although the generation of foam has little to do with the cleaning capacity of shampoo, it is of utmost importance to the consumer. Therefore, it is an important criterion in their evaluation. Most of the evaluated shampoos showed similar defoaming characteristics in distilled water.

Regarding the height of foam, most of the evaluated shampoos generated a good amount of foam; regarding the foam index, most of the evaluated products (19 of 20) formed closed foam. Closed foam is considered a better quality (there is no space between the bubbles), longer-lasting, and more easily rinseable than open foam (Ahad et al. 2013).

Notice of start of operation by the manufacturing company

The federal animal health law: Article 105 indicates that the owners of establishments that manufacture or sell pharmaceutical or biological chemical products for use in animals must give notice of the start of the operation to the secretariat (Ministry of Agriculture and Rural Development) (SADER), providing the name and address of the corresponding establishment, as well as the reference of what it handles or produces, within 15 calendar days after the start of operation. Some of the evaluated shampoos (3) did not meet this requirement (SENASICA 2012, 2018).

Regulation. registration or authorization

As stated in NOM-012-ZOO-1993, "the national or foreign manufacturing company dedicated to the production of chemical products for use in animals must have the manufacturing authorization of the country of origin". Three of the evaluated products did not show import data on their labels. Article 151 of the Federal Law on Animal Health Regulations establishes that chemical products for animal hygiene and beauty are subject to regulation (SENASICA 2004). NOM-059-ZOO-1997 establishes that these products must have a registration or authorization number. According to the analysis of the label, all the products evaluated (100%) complied with providing the name of the manufacturing company and the name of the country of origin. These rules and regulations are mandatory throughout the national territory, and their purpose is to establish the guidelines that advertising material for chemical products must comply with, subject to registration (SENASICA 2000).

Advertising material

Advertising material found on the label is addressed in NOM-059-Z00-1997 regarding Animal Health and the specifications of products for use in or consumption by animals. Section 4.3 indicates that the advertising material intended to be disseminated must be expressed in Spanish or provided in other languages as long as a translation into Spanish accompanies it. In this area, only 90% of the products evaluated complied with the corresponding regulations (SENASICA 2000).

Indications for use

The use of products made and used following the manufacturer's instructions and specifications contributes to protecting animal health, reducing animal health risks, and promoting safety following NOM--012-ZOO-1993. Section 8.2.3 states that in the indications, the use, species, and application must be expressed clearly and with commonly used terminology. All of the analyzed products complied with this specification (SENASICA 2004).

Lot number

NOM-012-Z00-1993 Section 3.27 states that any combination of letters, numbers, or symbols that serve to identify a batch and all documents related to its manufacturing and control are protected. The same rule in Section 3.21 defines the batch number as a specific quantity identified by a code that consists of any raw material or product that has been produced under equivalent operating conditions during a specified period. In this regard, 90% of the evaluated products complied with this information on their label (SENASICA 2004).

Date of expiration

NOM-012-ZOO-1993 refers to the expiration date, which is the date assigned to a product that designates the end of its period of use. Products lacking this information are not in compliance with legislation since this constitutes a health risk. Concerning the expiration date, only 65% of the evaluated products presented this information on their label (SENASICA 2004).

Usage warnings

Only 85% of the analyzed products contained warning information, although NOM-012-ZOO-1993 Section 8.24 (e) mentions that the indications for use, species, and application must be presented clearly and with commonly used terminology. Not including these data is a risk to the health and survival of companion animals since the concentration is not known. Alternatively, the species for which the use of the product is intended should be stated (SENASICA 2004).

Veterinarian use legend

NOM-012-ZOO-1993 in Section 8.22 specifies that veterinary products must bear on the label the Legend: veterinarian use; Article 8.24 b) and also establishes that they must bear the label consult with a veterinary doctor. This is of utmost importance because we must differentiate products for human use and those for companion animals to avoid confusion due to animal and human health risks. Only 80% of the products presented this information (SENASICA 2004).

Conclusions

Shampoos made for use on dogs must be designed according to the characteristics of the species. The shampoos must be harmless and comply with quality control measures to avoid dog health risks and create favorable conditions for microorganisms. For aesthetic, nonmedicated products, routine quality control measures should be published for veterinary products, as is done for human products, to guarantee their safety and efficacy to the consumer. Due to the enormous growth of the companion dog industry, this study may serve as a technical guide providing information for various regulators at the federal, state, and municipal levels. Additionally, this study offers support for the performance of verifications or inspections to ensure compliance with sanitary regulations to protect animal and public health. While not all quality control measures carried out have officially established values for either human or veterinary products, the present findings will be useful for internal quality control carried out in each laboratory.

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