

Veterinarians' attitudes towards use of nutraceuticals

Susan M. Elrod, Erik H. Hofmeister

Abstract

The objective of this study was to assess veterinarians' understanding of nutraceutical use in humans and companion animals and their motivation and circumstances for recommending nutraceuticals to clients. We administered a cross-sectional survey to veterinarians attending continuing education sessions at the University of Georgia (USA) College of Veterinary Medicine from 2012 to 2015 (N = 126). Information regarding veterinarians' age, year of graduation, practice focus, and typical approaches to nutraceutical use was compiled from the returned surveys. The results indicated that veterinarians are more familiar with nutraceutical use in animals than in humans and primarily recommend nutraceuticals to their clients for preventative purposes and/or due to client interest. Veterinarians believed that nutraceuticals were most useful for osteoarthritis and therefore use omega-3 fatty acid and glucosamine/chondroitin products more often than other products for both their patients and their own pets. Safety and efficacy were the most important considerations when deciding which nutraceuticals to recommend to clients. The survey results show that veterinarians are familiar with nutraceuticals and open to their use in patients when they perceive these products to be safe and efficacious.

Résumé

L'objectif de la présente étude était d'évaluer la compréhension des vétérinaires de l'utilisation des nutraceutiques chez les humains et les animaux de compagnie et leurs motivations et circonstances pour recommander des nutraceutiques aux clients. Nous avons réalisé une enquête transversale auprès de vétérinaires participant à des sessions de formation continue au College of Veterinary Medicine de l'University of Georgia (USA) entre 2012 et 2015 (N = 126). Les informations concernant l'âge, l'année de diplomation, le domaine de pratique, et les approches typiques à l'utilisation des nutraceutiques furent compilées à partir des questionnaires retournés par les vétérinaires. Les résultats indiquèrent que les vétérinaires sont plus familiers avec l'utilisation des nutraceutiques chez les animaux que chez les humains, et qu'ils recommandent les nutraceutiques à leurs clients à des fins préventives et/ou étant donné l'intérêt du client. Les vétérinaires croyaient que les nutraceutiques étaient les plus utiles lors d'ostéo-arthrose et ainsi utilisent des produits avec acides gras oméga-3 et glucosamine/chondroïtine plus souvent que les autres produits autant pour leurs patients que leurs propres animaux. La sécurité et l'efficacité étaient les facteurs les plus importants lors du choix des nutraceutiques à recommander aux clients. Les résultats de l'enquête démontrent que les vétérinaires sont familiers avec les nutraceutiques et sont favorables à leur utilisation chez des patients lorsqu'ils considèrent ces produits comme sécuritaires et efficaces.

(Traduit par Docteur Serge Messier)

Introduction

Complementary and alternative medicine (CAM) is defined as any therapy not considered part of conventional care (1). This may include chiropractic care, acupuncture, and herbal products. In veterinary and human medicine, nutraceuticals, or any product with both nutritional and pharmaceutical properties, may be used as part of CAM therapy (2). Nutraceuticals were first defined in the late 1980s and have been gaining interest ever since. Research in both human and veterinary medicine has indicated a significant interest in CAM and nutraceuticals, with approximately 32% to 36% of human patients having tried some form of CAM within the past 12 mo and approximately 29% of pet owners having considered nutritional supplements for their animals (3,4).

Human studies have shown that patients with the greatest interest in nutritional supplements tend to be the most health-conscious (5). This same attitude may motivate pet owners to provide beneficial

foods and supplements in order to preserve or improve their animals' health. In a survey of owners of dogs diagnosed with cancer, 90% of owners changed their dog's food after cancer diagnosis (6). Another survey of owners of cats diagnosed with chronic renal failure found that 38% of owners began administering dietary supplements after this diagnosis (7).

Patients do not always share their interest in CAM and nutraceuticals with health-care providers. In human medicine, physicians may not inquire about CAM use in their patients and patients do not consistently inform their physicians of CAM use (8). In veterinary medicine, perceptions vary even among veterinarians as to whether their colleagues approve of the use of nutritional products and supplements (9).

The objective of this study was to examine veterinarians' habits about their personal use of nutraceuticals and their recommendations for their use to clients and to compare these habits with their understanding of nutraceutical use in humans and animals. We

Auburn University College of Veterinary Medicine, 1010 Wire Road Auburn, Alabama 36832, USA.

Address all correspondence to Dr. Susan M. Elrod; telephone: (334) 728-8018 (office), e-mail: smelrod@auburn.edu (work), susangelic@gmail.com (personal).

Received September 18, 2018. Accepted December 6, 2018.

Table I. Demographics and practice focus of responding veterinarians.

	Response, n (%)
Gender	
Female	63 (50.0)
Male	51 (40.5)
No response	12 (9.5)
	Total = 126
Median age (years)	47
	Total = 126
Median year of graduation	1995
	Total = 126
Practice focus	
Small animal	110 (87.3)
Equine	3 (2.4)
Exotic	3 (2.4)
Mixed	9 (7.1)
Other (clinical instructor)	1 (0.8)
	Total = 126
Time spent discussing treatment options	
Less than 15 min	41 (32.5)
15 to 30 min	82 (65.1)
More than 30 min	1 (0.8)
No response	2 (1.6)
	Total = 126

hypothesized that veterinarians would rarely prescribe nutraceuticals to their clients but would more frequently administer them to their own pets and that veterinarians with a greater understanding of nutraceutical use in humans would be more likely to use them in their own pets and patients.

Materials and methods

The Institutional Review Board of the University of Georgia approved this study.

Survey distribution and development

The surveys were distributed at continuing education sessions held at the University of Georgia College of Veterinary Medicine from 2012 to 2015. Veterinarians attending these sessions were given the opportunity to complete the surveys, which were collected at the end of the session.

The survey included a cover letter explaining its intent and providing the American Veterinary Medical Association's definition of "nutraceuticals." Examples of nutraceuticals and their role in the CAM discipline were included at the beginning of the survey in an attempt to offset veterinarians' differing perceptions and understanding of CAM and nutraceuticals.

The survey itself consisted of questions regarding the age, year of graduation, gender, and species focus of the veterinarians. The next question asked veterinarians to indicate the amount of time usually spent discussing treatment options with clients. From there,

the survey included 8 questions assessing the veterinarians' understanding of nutraceuticals and their use in animals and humans. The next 5 questions assessed how regularly the veterinarians used nutraceuticals in their own pets and in their patients. The next set of questions determined which nutraceuticals the veterinarian most often recommended to their clients and the rationale for these recommendations. The same questions were then applied to the veterinarians' own pets. Veterinarians were then asked under what circumstances they discussed nutraceuticals with clients and in which disease states nutraceuticals were the most helpful. Finally, veterinarians were asked which sources they had previously used for information about nutraceuticals and any additional comments.

For the purposes of this study, owners bringing their pets to the veterinarian are referred to as "clients" and the pets that the veterinarians treat are referred to as "patients." Data are reported as mean \pm standard deviation and are descriptive in nature.

Results

Of the surveys distributed, 126 were returned. As the surveys were freely distributed without regard to the number of attendants at the education sessions, it was impossible to calculate the rate of participation. Results of the survey questions regarding veterinarian demographic and practice focus are provided in Table I. Most (87%) were small animal veterinarians and 65% indicated that they spent 15 to 30 min discussing treatment options with their clients.

Responses to questions about veterinarians' familiarity with nutraceuticals in human and veterinary medicine are presented in Table II. Most veterinarians were familiar with nutraceuticals and their use in human medicine, with almost 66% of respondents strongly agreeing that they knew what nutraceuticals were and nearly 67% strongly agreeing that they were aware of their use in human medicine. While most respondents also indicated that they knew how nutraceuticals work and could apply them to their patients, the majority (55%) expressed agreement rather than strong agreement with this statement. Most respondents either agreed with (33%) or were neutral (44%) to the statement that they understood how nutraceuticals work in human medicine. The majority agreed that they regularly recommend nutraceuticals to patients (51%) and felt comfortable using nutraceuticals for their own medical problems (43%). The majority also agreed that they would recommend nutraceuticals to family (41%) and friends (38%).

The frequency at which the respondents reported recommending nutraceuticals alone or in combination to their patients and use in their own pets, as well as how often their clients inquired about nutraceuticals are summarized in Table III. Most veterinarians often recommend nutraceuticals in combination with conventional drugs for their patients (60%). In their own pets, most veterinarians reported sometimes (39%) or often (29%) using nutraceuticals in combination with other drugs. Most veterinarians reported rarely (40%) or sometimes (39%) recommending nutraceuticals alone for their patients. In their own pets, many of the respondents reported never, rarely, or sometimes using nutraceuticals alone in their own pets (22%, 36%, and 31%, respectively). Most veterinarians (53%) responded that their clients sometimes requested information about nutraceuticals.

Table II. Veterinarians' responses to questions about familiarity with nutraceuticals, N = 126.

Statement	Strongly disagree <i>n</i> (%)	Disagree <i>n</i> (%)	Neutral <i>n</i> (%)	Agree <i>n</i> (%)	Strongly agree <i>n</i> (%)	No response <i>n</i> (%)
Before this survey, I knew what nutraceuticals were.	1 (0.8)	1 (0.8)	1 (0.8)	40 (31.7)	83 (65.9)	0 (0)
I am aware that nutraceuticals are used for people with illnesses.	0 (0)	2 (1.6)	3 (2.4)	36 (28.6)	84 (66.7)	1 (0.8)
I know how nutraceuticals work and how to apply them to my patients.	2 (1.6)	4 (3.2)	30 (23.8)	69 (54.8)	21 (16.7)	0 (0)
I know how nutraceuticals work in human medicine.	2 (1.6)	14 (11.1)	56 (44.4)	42 (33.3)	21 (16.7)	0 (0)
I regularly include nutraceuticals in my recommendations for patients.	3 (2.4)	13 (10.3)	20 (15.9)	64 (50.8)	26 (20.6)	0 (0)
I feel comfortable using nutraceuticals for my own medical problems.	4 (3.2)	14 (11.1)	29 (23.0)	54 (42.9)	25 (19.8)	0 (0)
I would recommend that my family members use nutraceuticals if they are unwell.	5 (4.0)	14 (11.1)	35 (27.8)	51 (40.5)	21 (16.7)	0 (0)
I would recommend that my friends use nutraceuticals if they are unwell.	6 (4.8)	12 (9.5)	40 (31.7)	48 (38.1)	20 (15.9)	0 (0)

Table III. Veterinarians' responses to questions about frequency of nutraceutical recommendation and use and client requests, N = 126.

Statement	Never <i>n</i> (%)	Rarely <i>n</i> (%)	Sometimes <i>n</i> (%)	Often <i>n</i> (%)	Always <i>n</i> (%)	No response <i>n</i> (%)
I use nutraceuticals in combination with conventional drugs for patients' medical problems.	2 (1.6)	6 (4.8)	31 (24.6)	76 (60.3)	11 (8.7)	0 (0)
I recommend nutraceuticals alone to my clients for their pets' medical problems.	6 (8.3)	50 (39.7)	49 (38.9)	18 (14.3)	1 (0.8)	0 (0)
My clients request information about using nutraceuticals for their pets' medical conditions.	0 (0)	28 (22.2)	67 (53.2)	29 (23.0)	2 (1.6)	0 (0)
I use nutraceuticals in combination with conventional drugs for my own pet's medical problems.	8 (6.3)	15 (11.9)	49 (38.9)	36 (28.6)	17 (13.5)	1 (0.8)
I use nutraceuticals alone for my own pet's problems.	28 (22.2)	45 (35.7)	39 (31.0)	12 (9.5)	2 (1.6)	0 (0)

Table IV. Nutraceuticals recommended for patients or used by veterinarians for their own pets.

Product	Recommended for patients, n (%)	Used in own pets, n (%)
Omega-3 fatty acids	119 (94.4)	70 (55.6)
Glucosamine/chondroitin	117 (92.9)	88 (69.8)
Specific vitamins (A, B, E, etc.)	38 (30.2)	8 (6.30)
Multivitamins	30 (23.8)	18 (14.3)
SAM-E (with or without sylibin)	21 (16.7)	0 (0)
Milk thistle	12 (9.5)	1 (0.8)
Tea tree oil	10 (7.9)	1 (0.8)
Other ^a	59 (46.8)	17 (13.5)
None	2 (1.6)	2 (1.6)

^a Fewer than 10 veterinarians recommended or used products that are not listed, including but not limited to, probiotics, *Echinacea*, garlic, and cranberry.

Table V. Circumstances under which veterinarians recommended nutraceuticals to their clients.

Circumstance	n (%)
When the client requests such treatments	98 (77.8)
Before the onset of disease	92 (73.0)
When traditional treatment has failed	45 (35.7)
As a "last ditch" effort	20 (15.9)
Never	1 (0.8)
Other ^a	3 (2.4)

^a In combination with another treatment, for economic reasons, or for specific conditions.

Table VI. Nutraceutical resources identified by veterinarians.

Circumstance	n (%)
Publications/clinical studies/evidence-based medicine	48 (38.1)
Product representatives/manufacturer/formulary/ product availability	46 (36.5)
Veterinary Information Network/International Veterinary Information Service/National Institutes of Health	24 (19.0)
Unspecified online resources	17 (13.4)
Colleagues/friends/family	17 (13.4)
Continuing education or other courses	13 (10.3)
Specialists/fact-checking resources	9 (7.1)
Personal/clinical experience	8 (6.3)
Textbooks	8 (6.3)
Pamphlets/media	7 (5.6)
Human medicine literature	6 (4.8)

The nutraceutical products that veterinarians most often recommended to their clients or used in their own pets are listed in Table IV. Omega-3 fatty acid products were the most frequently recommended to clients (94%), followed closely by glucosamine/chondroitin products (93%). These were also the most frequently used on the veterinarians' own pets, with approximately 56%

administering omega-3 fatty acid products and 70% administering glucosamine/chondroitin products. Some veterinarians also recommended either multivitamins (24%) or specific vitamins (30%) to their clients. Far fewer veterinarians used vitamin products in their own pets, with approximately 14% using multivitamins and 6% using specific vitamins.

A few products were recommended to clients but were not used by the veterinarians in their own pets. These included S-adenosyl-L-methionine (SAM-E), with or without sylibin, which was recommended by 17% of veterinarians, but none reported using it in their own pets. Milk thistle and tea tree oil were used by only 1 veterinarian for his or her own pets, but were recommended by 10% and 8% of veterinarians, respectively. Two veterinarians never recommended nutraceutical products to their clients or used them for their own pets.

The ranking that each veterinarian gave to the importance of issues for their own pets as opposed to for those of their clients was averaged and compared, as presented in Figure 1. The veterinarians ranked every issue as being slightly more important for their own pets than for recommending to clients. As some veterinarians indicated that their pets are healthy and do not require treatment, however, the lower ranking for the other issues may have reduced the average ranking. Safety and efficacy of nutraceuticals were the most important issues in determining their use in both clients and the veterinarians' own pets. Exhaustion of alternatives was the least important factor for recommendation to clients, with the other issues ranking approximately equal. For the veterinarians' own pets, exhaustion of alternatives was also least important, followed closely by cost issues and availability. Concern about adverse effects and interactions with other drugs or conditions was approximately equal for the veterinarians' own pets and for those of their clients. Other issues of concern for client recommendation included inconsistencies or lack of regulation, side effects, inadequacy of conventional treatment, use as an adjunct therapy, and anecdotal evidence. For the veterinarians' own pets, colleague expertise, difficulty or ease of administration, side effects, and inadequacy of conventional treatment were listed as other issues of concern.

The circumstances under which the veterinarians reported recommending nutraceuticals to their clients are listed in Table V. Most respondents recommended nutraceuticals at the request of clients (78%) or before the onset of disease (73%). Other reasons for recommending nutraceuticals were when conventional treatment had failed or as a "last ditch" effort (36% and 16%, respectively). Other reasons included use in combination with other medications, economic reasons, or for specific conditions. Only 1 veterinarian indicated never using nutraceuticals, which contradicted the 2 veterinarians who indicated that they never used nutraceuticals when questioned about what products they used or recommended.

The ranking of conditions for which the veterinarians felt nutraceuticals might be most useful is presented in Figure 2. The condition that veterinarians ranked highest was osteoarthritis. Dermatologic disease was also ranked relatively high, followed by gastrointestinal and liver disease. Renal disease was ranked somewhat lower, with cardiac disease, cancer, and dental disease all ranked relatively low.

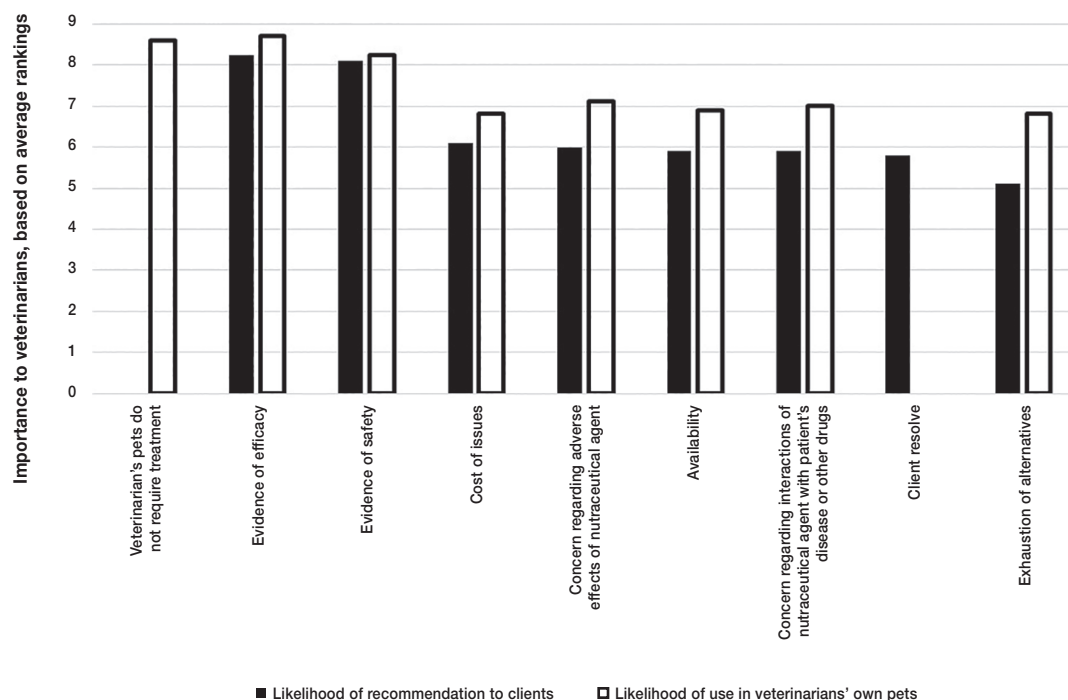


Figure 1. Average ranking of importance of issues in determining whether veterinarians recommend nutraceuticals for their patients (N = 126).

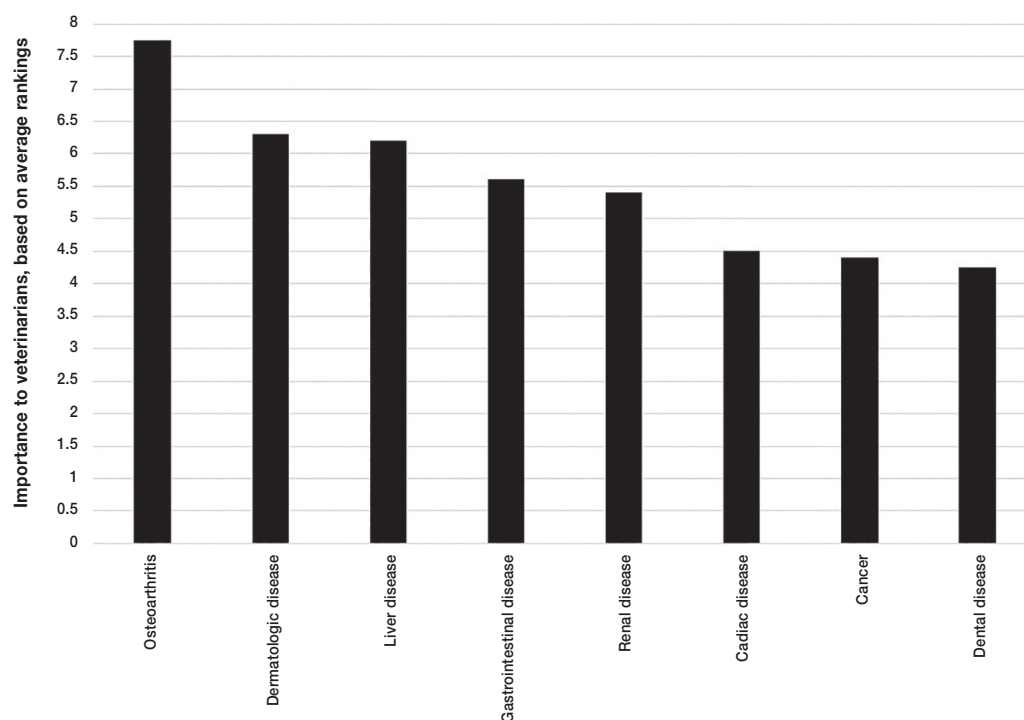


Figure 2. Average ranking of conditions for which veterinarians perceive nutraceuticals to be beneficial (N = 126).

The most frequently listed resource for information about nutraceuticals was scientific articles (38%), followed closely by information provided by the manufacturer (36%) (Table VI). Other frequently listed resources were organizations such as the Veterinary Information Network or National Institutes of Health (19%),

unspecified online resources (13%), colleagues/friends/family (13%), and continuing education and other courses (10%). Ten or fewer respondents listed continuing education and other courses, specialists, personal or clinical experience, textbooks, pamphlets or popular media, and literature relating to human medicine.

Discussion

Veterinarians tended to be aware of the use of nutraceuticals in both humans and animals, although they were slightly more familiar with their mechanism of action in animals than in humans. This is likely due to the veterinarians' training rather than greater use of nutraceuticals. At the time of writing, a PubMed search of "nutraceutical" in humans returned a much higher number of results than the same search for animals (approximately 42 000 results compared to approximately 22 000). "Veterinary nutraceutical use" yielded approximately 7000 results, which indicates that most research appears to have been carried out in humans, thus requiring extrapolation to veterinarians' patients. Veterinarians are therefore more likely to use nutraceuticals in their pets than to treat their own personal medical conditions, which is likely due to their greater expertise and understanding of these products in companion animals.

Veterinarians are also more likely to use nutraceuticals themselves than to recommend them to friends or family. This may be attributed to the "do no harm" mentality among medical professionals, with most practitioners reluctant to recommend products that they are not fully confident in to others, especially non-patients, even if they are confident enough to use the products themselves. Additionally, the prospect of litigation may make veterinarians reluctant to recommend products to anyone other than their own clients.

In practice, veterinarians reported being most likely to use nutraceuticals in combination with other medications, perhaps due to their desire to use nutraceuticals only if they are confident of the best possible outcome. In this case, using nutraceuticals to augment accepted therapy would theoretically yield better results than using either therapy alone, due to either additive or synergistic effects. Another strategy that has been explored is the ability of certain nutraceuticals to prevent or limit the adverse effects of conventional therapy. Various studies have shown improved efficacy and/or safety with the use of conventional and nutraceutical therapies (10–15). Veterinarians also reported frequently recommending nutraceuticals before the onset of disease, i.e., for preventative purposes, which is consistent with conventional wisdom that preventing disease is better than attempting to treat an already established condition. Client resolve was also a frequent motivator for the recommendation of nutraceutical products, consistent with research in human medicine that indicates some patients visit their physician specifically to inquire about a particular medication (16).

The condition that veterinarians most frequently treated with nutraceuticals was osteoarthritis, which is consistent with omega-3 fatty acids and glucosamine/chondroitin products being the most frequently used. Indeed, 1 respondent who expressed distaste for nutraceuticals nevertheless listed omega-3 fatty acid products as a recommendation. Interestingly, veterinarians recommend glucosamine/chondroitin products to clients almost as frequently as omega-3 fatty acids and used them more frequently in their own pets, despite the relative lack of research on these products in companion animals compared to research into omega-3 fatty acid products in companion animals (17–23). As many veterinarians indicated that they use the manufacturer's literature to make recommendations, it is possible that the use of glucosamine/chondroitin

is due to advertising by manufacturers. The use of these relatively untested products in the veterinarians' own pets compared to their patients may also indicate an unwillingness to recommend less proven products for their patients.

In conclusion, veterinarians are familiar with nutraceuticals and willing to consider them if the client is interested. Evidence-based publications were the most commonly cited source veterinarians used to determine which nutraceuticals to recommend and for which conditions. Veterinarians were clearly interested in the efficacy and safety of nutraceutical products and concerned about the evidence for their use. As we can only speculate on the reasons for these attitudes, further research may be warranted to determine the rationale behind them. As many veterinarians expressed concern about the evidence for the efficacy and safety of nutraceutical products, it is also recommended that strong scientific rigor be applied to nutraceutical products that are marketed for use in companion animals.

References

1. Barnes PM, Powell-Griner E, McFann K, Nahin RL. Complementary and alternative medicine use among adults: United States, 2002. *Adv Data* 2004;343:1–19.
2. Kalra EK. Nutraceutical — Definition and introduction. *AAPS PharmSci* 2003;5:27–28.
3. Clark TC, Black LI, Stussman BJ, Barnes PM, Nahin RL. Trends in the use of complementary health approaches among adults: United States, 2002–2012. *Natl Health Stat Report* 2015;79:1–16.
4. L. Phillips Brown. Pet nutraceuticals. Hype or wave of the future? *Nutraceuticals World*. http://www.nutraceuticalsworld.com/issues/2001-01/view_features/pet-nutraceuticals. Last accessed June 22, 2019.
5. Beitz R, Mensink GB, Hintzpeter B, Fischer B, Erbersdobler HF. Do users of dietary supplements differ from nonusers in their food consumption? *Eur J Epidemiol* 2004;19:335–341.
6. Rajagopaul S, Parr JM, Woods JP, Pearl DL, Coe JB, Verbrugghe A. Owners' attitudes and practices regarding nutrition of dogs diagnosed with cancer presenting at a referral oncology service in Ontario, Canada. *J Small Anim Pract* 2016;57:484–490.
7. Markovich JE, Freeman LM, Labato MA, Heinze CR. Survey of dietary and medication practices of owners of cats with chronic kidney disease. *J Feline Med Surg* 2015;17:979–983.
8. Godwin M, McCrate F, Newhook LA, et al. Use of natural health products in children: Experiences and attitudes of family physicians in Newfoundland and Labrador. *Can Fam Physician* 2013;59:e357–363.
9. Towell TL, Hampe S, Wayner CJ. Referring veterinarians' opinions and veterinary teaching hospital veterinarians' perceptions of those opinions regarding communication and nutritional product recommendations. *J Am Vet Med Assoc* 2010;237:513–518.
10. Kong L, Wang X, Zhang K, et al. Gypenosides synergistically enhances the anti-tumor effect of 5-fluorouracil on colorectal cancer in vitro and in vivo: A role for oxidative stress-mediated DNA damage and p53 activation. *PLoS One* 2015;10:e0137888.
11. Cao S, Xia M, Mao Y, et al. Combined oridonin with cetuximab treatment shows synergistic anticancer effects on laryngeal squamous cell carcinoma: Involvement of inhibition of EGFR and

- activation of reactive oxygen species-mediated JNK pathway. *Int J Oncol* 2016;49:2075–2087.
12. Maceo EM, Santos WC, Sousa BP Neto, et al. Association of terpinolene and diclofenac presents antinociceptive and anti-inflammatory synergistic effects in a model of chronic inflammation. *Braz J Med Biol Res* 2016;49:e5103.
 13. Miladinović DL, Ilić BS, Kocić BD, Marković MS, Miladinović LC. In vitro trials of *Dittrichia graveolens* essential oil combined with antibiotics. *Nat Prod Commun* 2016;11:865–868.
 14. Bunel V, Antoine MH, Nortier J, Duez P, Stévigny C. Potential nephroprotective effects of the Chinese herb *Angelica sinensis* against cisplatin tubulotoxicity. *Pharm Biol* 2015;53:985–994.
 15. Bunel V, Antoine MH, Nortier J, Duez P, Stévigny C. Nephroprotective effects of ferulic acid, Z-ligustilide and E-ligustilide isolated from *Angelica sinensis* against cisplatin toxicity in vitro. *Toxicol in Vitro* 2015;29:458–467.
 16. Akin KJ, Swasy JL, Braman AC. Patient and physician attitudes and behaviors associated with DTC promotion of prescription drugs — Summary of FDA survey research results. US Food and Drug Administration, Center for Drug Evaluation and Research, 2004.
 17. McCarthy G, O'Donovan J, Jones B, McAllister H, Seed M, Mooney C. Randomised double-blind, positive-controlled trial to assess the efficacy of glucosamine/chondroitin sulfate for the treatment of dogs with osteoarthritis. *Vet J* 2007;174:54–61.
 18. Lascelles BD, DePuy V, Thomson A, et al. Evaluation of a therapeutic diet for feline degenerative joint disease. *J Vet Intern Med* 2010;24:487–495.
 19. Rialland P, Bichot S, Lussier B, et al. Effect of a diet enriched with green-lipped mussel on pain behavior and functioning in dogs with clinical osteoarthritis. *Can J Vet Res* 2013;77:66–74.
 20. Fritsch DA, Allen TA, Dodd CE, et al. A multicenter study of the effect of dietary supplementation with fish oil omega-3 fatty acids on carprofen dosage in dogs with osteoarthritis. *J Am Vet Med Assoc* 2010;236:535–539.
 21. Roush JK, Cross AR, Renberg WC, et al. Evaluation of the effects of dietary supplementation with fish oil omega-3 fatty acids on weight bearing in dogs with osteoarthritis. *J Am Vet Med Assoc* 2010;236:67–73.
 22. Barrouin-Melo SM, Anturaniemi J, Sankari S, et al. Evaluating oxidative stress, serological and haematological status of dogs suffering from osteoarthritis, after supplementing their diet with fish or corn oil. *Lipids Health Dis* 2016;15:139.
 23. Mehler SJ, May LR, King C, Harris WS, Shah Z. A prospective, randomized, double blind, placebo-controlled evaluation of the effects of eicosapentaenoic acid and docosahexaenoic acid on the clinical signs and erythrocyte membrane polyunsaturated fatty acid concentrations in dogs with osteoarthritis. *Prostaglandins Leukot Essent Fatty Acids* 2016;109:1–7.