Review

Study on Nutritional and Health Management Strategies for Benign Tumors in Companion Animals: A Focus on Lipoma

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Abstract: Canine lipoma is the most common benign soft-tissue tumor encountered in veterinary clinical practice, representing approximately 12% of all canine cutaneous tumors. With increasing pet longevity and evolving feeding practices, its detection rate continues to show a steady year-on-year rise. Traditional surgical resection carries a relatively high recurrence rate and significant anesthesia-related risks for geriatric dogs, driving growing interest in alternative nutritional regulation strategies. This review systematically summarizes the epidemiological characteristics of canine lipoma and analyzes the impact of specific dietary components—including medium-chain triglycerides, epigallocatechin gallate, and curcumin—on anti-inflammatory responses, lipid metabolism regulation, and lipogenesis inhibition. Furthermore, a comprehensive nutritional intervention program centered on weight management is proposed. The study also examines the synergistic regulatory effects of medicinal mushroom-based formulations on immune modulation, anti-inflammatory activity, and metabolic reprogramming, ultimately developing a functional supplementation strategy. Dogs serve as the primary research model due to the high incidence of lipomas, abundant epidemiological data, and significant clinical challenges, such as nerve compression and impaired mobility. The strong demand for non-surgical, conservative treatments among pet owners further justifies this focus. Because the pathogenesis of canine lipoma shares similarities with benign lipomas in other mammals, these proposed nutritional intervention strategies may improve clinical management in dogs while providing valuable translational insights for non-surgical interventions in other animals and potentially humans.

Keywords: canine lipoma; benign tumor; nutritional regulation; lipid metabolism; weight management

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1. Introduction

Cancer is one of the leading causes of death in dogs, with tumors capable of affecting a wide range of organs and tissues. However, the most commonly encountered subcutaneous masses in clinical practice are not malignant but rather lipomas—benign tumors formed by the proliferation of mature adipocytes. The majority of superficial masses detected by owners during routine grooming are lipomas, and dogs presenting with a single lipoma are more likely to develop multiple lesions over time. A retrospective study of canine skin tumors identified lipoma as the most prevalent benign tumor. Furthermore, an analysis of biopsy samples reported that, among dogs diagnosed with cutaneous and subcutaneous fibrolipoma, the median age of onset was 8.0 ± 2.8 years, with an average tumor size of 2.9 ±2.3 cm. The head was the most commonly affected site (31.9%), and a higher incidence was observed in neutered male dogs and Labrador Retrievers. Although lipomas generally carry a favorable prognosis, progressive enlargement may compress adjacent nerves and blood vessels, thereby impairing mobility [1]. In rare cases, there is also a risk of malignant transformation into liposarcoma. Surgical excision remains the conventional treatment; however, it is associated with a relatively high recurrence rate and poses increased anesthesia-related risks, particularly in geriatric dogs. These limitations highlight the clinical significance and growing demand for conservative management strategies based on nutritional regulation. In recent years, functional nutrition has gained increasing attention in the management of chronic canine diseases. Dietary components such as omega-3 fatty acids, medium-chain triglycerides (MCTs), and plant-derived polyphenols have demonstrated potential in inhibiting lipoma progression and improving quality of life through anti-inflammatory, antioxidant, and lipid metabolism-modulating effects. Additionally, preliminary clinical observations suggest that functional formulations, including organic medicinal mushroom blends, may offer supportive benefits. Such approaches are particularly relevant for elderly dogs with poor surgical tolerance or those presenting with multiple lipomas, providing a scientific basis for non-surgical intervention strategies.

2. Epidemiological Characteristics and High-Risk Groups of Canine Lipoma

2.1. Incidence and Breed Predisposition

Canine lipoma is the most common benign soft-tissue tumor in clinical practice [2]. Among 64,560 biopsy samples, 236 cases were identified as cutaneous and subcutaneous fibrolipomas, with a significantly higher incidence in neutered male dogs (46.2%, P = 0.013) and Labrador Retrievers (23%, P = 0.047). Data from North China indicated that lipomas accounted for 12.06% of all canine skin tumors, with high-incidence sites including the limbs, head, perineum, buttocks, and tail, as shown in Table 1.

Table 1. Incidence Statistics

Characteristic Dimension	Data Statistics
Proportion in canine skin tumors	12.06% (17/141 cases)
Median age at onset	8 years (±2.8 years)
Mean tumor size	2.9 cm (±2.3 cm)
Most frequent locations	Head (31.9%), carpus (10.3%), elbow (9.9%)
Breed predisposition	Labrador Retriever (23%, P = 0.047)
Sex predisposition	Neutered male dogs (46.2%, P = 0.013)

There are notable regional differences in tumor distribution. Data from North China indicate that lipomas most frequently occur in the forelimbs (21.54%), followed by the hindlimbs (16.92%) and head (16.15%). In contrast, data from the southeastern United States show the highest incidence in the head (31.9%), followed by the carpus (10.3%) and elbow (9.9%). These variations may be attributed to differences in breed composition across regions (with Labrador Retrievers being common in both North China and the United States), as well as environmental factors such as climate, which can influence subcutaneous fat metabolism and the skin microenvironment. Additionally, feeding practices may affect outdoor activity levels and dietary structure. Therefore, both individual and regional factors should be considered when developing nutritional intervention strategies [3].

2.2. Age and Obesity Factors

Age is a significant risk factor for canine lipoma. The condition is rare in young dogs, with incidence increasing progressively with age, particularly in middle-aged and senior animals [2]. It is generally more common after the age of 7, with the highest frequency observed in dogs aged 5–10 years. Studies on oral fibrolipoma have reported a mean age of onset of 10.1 years (range: 2–16 years). With aging, metabolic rate declines, adipose tissue redistribution occurs, and chronic low-grade inflammation persists, all of which create a biological environment that facilitates the differentiation of adipocyte precursors. Obesity is more directly associated with lipoma development. Increased body fat leads to pathological expansion of adipose tissue, characterized by adipocyte hypertrophy and hyperplasia, accompanied by macrophage infiltration and the release of inflammatory mediators, resulting in chronic low-grade inflammation. This microenvironment can activate adipogenic transcription factors such as PPAR-γ and C/EBPα, promoting abnormal differentiation of preadipocytes and significantly increasing lipoma risk. The incidence of lipoma in obese dogs (BCS ≥ 7/9) is approximately 2–3 times higher than in dogs with normal body weight, and the occurrence of multiple lipomas is also more frequent. The starch content of modern commercial pet dry food typically ranges from 40% to 60% to facilitate processing and palatability. Animal nutritionists suggest that high-starch diets may contribute to lipoma development. High-glycemic carbohydrates can rapidly elevate blood glucose levels, triggering substantial insulin secretion. As insulin promotes lipogenesis, chronically elevated insulin levels can induce adipocyte hypertrophy and proliferation while inhibiting lipolysis, thereby creating a vicious cycle of "hyperinsulinemia–fat accumulation–inflammation–lipoma progression." This cycle may be mitigated by reducing refined starch intake and incorporating low-glycemic carbohydrates (e.g., legumes and vegetables) or high-quality animal protein sources. Weight management is a central component of non-surgical intervention for lipoma [4]. Appropriate caloric restriction can not only help prevent the formation of new lipomas but may also reduce the size of existing lesions. The underlying mechanisms include decreased adipose tissue storage, reduced levels of free fatty acids and leptin, alleviation of chronic inflammation, improved insulin sensitivity, and downregulation of adipogenesis-related signaling pathways. In some clinical cases, dietary modification—characterized by high protein, low starch intake, and supplementation with fish oil and medium-chain triglycerides (MCTs)—combined with caloric control has resulted in a 10%–30% reduction in lipoma size within 3–6 months, with no new lesions observed. For overweight or obese dogs with lipoma, individualized weight reduction plans (targeting 0.5%–1% body weight loss per week) should be implemented, with nutritional management as the primary intervention.

3. Mechanism and Evidence of Dietary Components in Lipoma Regulation

3.1. Omega-3 Long-Chain Polyunsaturated Fatty Acids

Among dietary anti-inflammatory components, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) derived from fish oil have been extensively studied. Their primary mechanism involves modulating the balance of eicosanoids, promoting the synthesis of pro-resolving mediators such as resolvins and protectins, and thereby suppressing chronic inflammatory responses. Lipoma development is closely associated with chronic inflammation in the local tissue microenvironment, and inhibition of inflammatory signaling pathways may reduce abnormal adipocyte proliferation at its source. In a randomized controlled trial, 64 dogs were assigned to a control group, a 7% MCT group, a fish oil group (EPA 0.18% + DHA 1.3%), and a combined fish oil + MCT group for a 28-day feeding intervention. The results demonstrated that fish oil supplementation, with or without MCT, significantly reduced serum triglyceride and total cholesterol levels and improved lipid profiles in dogs. This finding is directly relevant to lipoma management, as reductions in circulating lipid levels may help limit the differentiation and proliferation of adipocyte precursor cells [5, 6]. The recommended dosage range of EPA for canine dermatological conditions is 0.99–43 mg/kg body weight, and for DHA is 0.66–30 mg/kg body weight [7]. It is recommended to use high-quality canine fish oil products and to gradually increase dosage from a low starting level to improve tolerance.

3.2. Medium-Chain Triglycerides (MCT)

Medium-chain triglycerides (MCTs) are composed of fatty acids with 6–12 carbon atoms and exhibit metabolic pathways distinct from long-chain fatty acids. Unlike long-chain lipids, MCTs do not require the carnitine transport system and can directly enter mitochondria for β-oxidation, rapidly generating ketone bodies as an alternative energy source. Additionally, MCTs have been shown to reduce fat storage and improve overall lipid utilization efficiency (As shown in Figure 1).

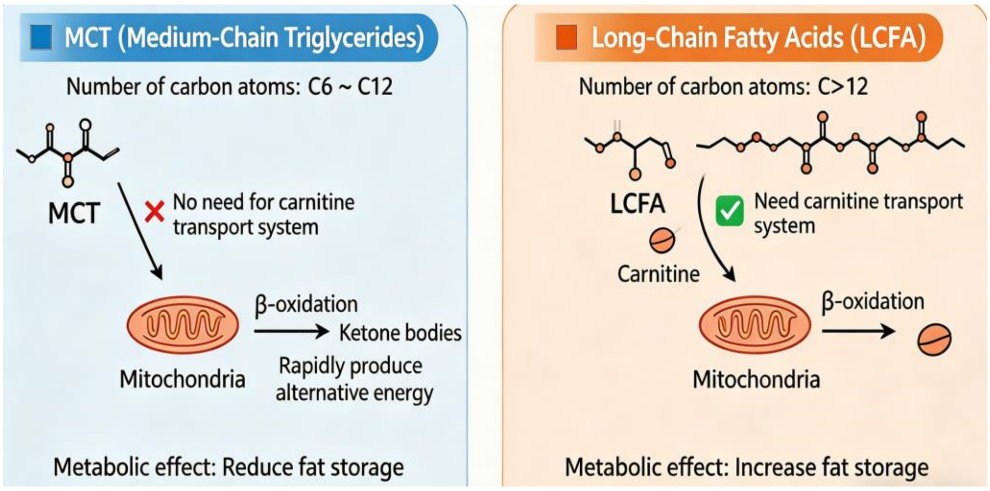

Figure 1. Metabolic Characteristics of Medium-Chain Triglycerides

Recent studies indicate that MCT supplementation may exert broad metabolic effects in dogs. Dietary MCT intake has been shown to alter circulating lipid species, including triglycerides, glycerophospholipids, and cholesterol esters, while also influencing ketone bodies and amino acid-related metabolites such as glutamine [3]. These findings suggest that MCTs may help reprogram systemic metabolic networks in dogs, thereby playing an important role in metabolic regulation. Furthermore, MCT supplementation has been associated with reduced serum levels of N-acyl taurine, which may contribute to decreased lipid-associated inflammation. Notably, the synergistic interaction between fish oil and MCT deserves attention. Combined supplementation has been shown to produce distinct metabolic signatures—affecting acylcarnitines, ω-oxidized dicarboxylic acids, and amino acids—compared with single supplementation, suggesting a complementary effect in optimizing lipid metabolism regulation. The recommended supplementation level of MCT in canine diets is approximately 7%, consistent with experimental studies. Commercial functional pet foods containing MCT or veterinary-grade MCT oil supplements may be selected for practical application.

3.3. Green Tea Polyphenols (EGCG)

Epigallocatechin gallate (EGCG) is the principal active component of green tea polyphenols, accounting for 56%–72% of green tea extracts. Its regulatory effects on lipoma are mainly reflected in three aspects: EGCG exerts strong antioxidant activity by scavenging free radicals and modulating NF-κB activity, thereby reducing oxidative stress within the adipose tissue microenvironment; EGCG suppresses the differentiation and proliferation of preadipocytes through the induction of apoptosis and the inhibition of angiogenesis; moreover, tea polyphenols regulate the expression of obesity-related genes and downregulate COX-2 and iNOS expression in dogs fed a high-fat diet. It should be noted that EGCG has relatively low bioavailability and therefore is often combined with other polyphenolic compounds in functional food formulations to enhance absorption efficiency. Commercial products such as Thornevet have developed polyphenol complexes with improved bioavailability (As shown in Figure 2).

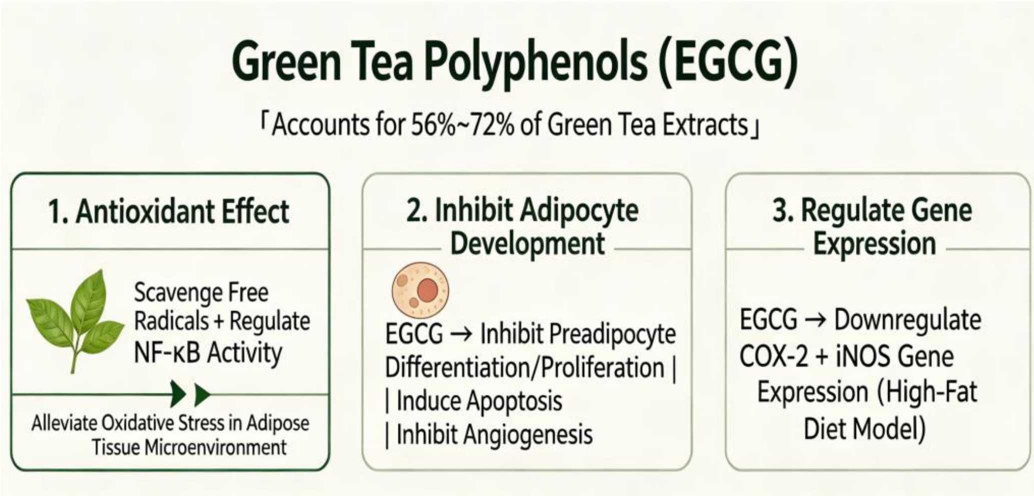

Figure 2. Schematic Representation of Green Tea Polyphenols

3.4. Curcumin

Curcumin is a natural polyphenolic compound derived from the rhizome of Curcuma longa. Its role in regulating lipid metabolism has gained increasing attention in recent years. Research indicates that curcumin can influence adipocyte development, exerting multi-target effects on fat cells by promoting the conversion of white adipocytes into brown adipocytes, thereby improving lipid metabolism disorders and obesity-related inflammation [4, 8]. In livestock and poultry production, curcumin has been demonstrated to provide multiple benefits, including lipid-lowering, anti-inflammatory, and antioxidant effects. A study on curcumin supplementation in dogs provided direct evidence: twenty healthy beagles were divided into control and experimental groups, with the experimental group receiving feed containing 0.024% controlled-release curcumin (VEO Fulikang). After 56 days, both triglyceride levels and SOD activity showed significant reductions in the experimental group compared to the control group, suggesting that curcumin can improve glucose metabolism disorders by regulating lipid metabolism, enhancing the antioxidant defense system, and protecting liver function.

3.5. Comparison of Regulatory Mechanisms of Various Dietary Components

Table 2 summarizes the mechanisms by which dietary components regulate lipoma, along with the current levels of evidence and application references. Mechanistically, omega-3 fatty acids (EPA/DHA) primarily lower circulating lipid levels by suppressing chronic inflammatory responses. Randomized controlled trials have established reference dosages of 0.99–43 mg/kg body weight for EPA and 0.66–30 mg/kg body weight for DHA. Medium-chain triglycerides (MCTs) offer a distinct advantage through metabolic reprogramming, bypassing the carnitine-dependent transport system for direct oxidation, thereby reducing fat accumulation and improving systemic lipid metabolism. Their efficacy is supported by randomized controlled trials and metabolomics studies, with a typical dietary inclusion level of around 7%. EGCG from green tea exhibits antioxidant properties and inhibits adipogenesis, though current evidence is mainly derived from experimental and observational studies. In practical applications, polyphenol complex formulations are recommended to enhance bioavailability. Curcumin promotes the browning of white adipocytes and regulates lipid metabolism through lipid-lowering and anti-inflammatory effects. Its efficacy has been confirmed in controlled canine studies, where dietary supplementation with 0.024% controlled-release curcumin demonstrated beneficial outcomes. From the perspective of targets and potency, these dietary components differ in both their mechanisms and strength of action. In practical nutritional interventions, strategies can be tailored to individual dogs, with either single or combined supplementation selected based on specific conditions and needs [9, 10].

Table 2. Comparison of Regulatory Mechanisms of Various Dietary Components

Dietary Component	Main Mechanisms of Action	Evidence Level in Dogs	Main Application Reference
Omega-3 (EPA/DHA)	Anti-inflammatory effects; reduction of blood lipid levels	Randomized controlled trials	EPA 0.99–43 mg/kg; DHA 0.66–30 mg/kg
MCT	Induces metabolic reprogramming; lowers circulating lipid levels	Randomized controlled trials + metabolomics studies	7% of dietary inclusion
EGCG	Antioxidant activity; suppression of adipogenesis	Cell-based studies + canine observational studies	Polyphenol complex formulations
Curcumin	Promotes adipocyte browning; reduces lipid levels	Controlled trials in dogs	0.024% dietary supplementation

3.6. Synergistic Regulation of Medicinal Mushroom Compound Formulas

In recent years, scientifically formulated compound blends, such as the patented "organic mushroom mixture" (Application No. 19/011176), composed of core ingredients like Coriolus versicolor, Ganoderma lucidum, Lentinus edodes, white birch antler, Hericium erinaceus, Tricholoma matsutake, Cordyceps sinensis, and Brazilian mushroom (optionally combined with Flammulina velutipes, Tremella fuciformis, or Poria cocos), have gained increasing attention for their roles in immune modulation, anti-inflammation, and anti-tumor activity. These formulations may provide new strategies for the nutritional regulation of canine lipoma through multi-target synergistic effects. The underlying mechanisms involve several complementary pathways. β-glucans from Coriolus versicolor and Ganoderma lucidum can activate macrophages and natural killer cells, aiding in resolving local chronic inflammation, inhibiting abnormal adipocyte proliferation, and complementing the anti-inflammatory actions of omega-3 fatty acids. Lentinan from Lentinus edodes and bioactive compounds in Cordyceps sinensis, known for enhancing ATP production, contribute to metabolic reprogramming and reduce fat accumulation at the energy metabolism level. White birch antler, along with antioxidant components in Hericium erinaceus, provides protection against oxidative stress, a key driver of preadipocyte differentiation; thus, scavenging free radicals may inhibit the formation of new adipocytes, a mechanism comparable to that of EGCG. Additionally, the patented formulation applies precise weight ratios of different mushroom components to optimize health benefits. In one representative composition, the proportions are as follows: 34% Coriolus versicolor, 15% Lentinus edodes, 13% Ganoderma lucidum, 9% Hericium erinaceus, 8% Grifola frondosa, 6% Brazilian mushroom, 6% Cordyceps sinensis, 5% Tremella fuciformis, and 4% white birch mushroom sclerotia. Within this system, Ganoderma lucidum and Lentinus edodes enhance β-glucan-mediated immune activation; Hericium erinaceus and Betula platyphylla contribute neuroprotective and antioxidant effects; while Cordyceps sinensis and Grifola frondosa synergistically regulate energy metabolism. In variant formulations, Flammulina velutipes (2%–6%) or Poria cocos (2%–6%) may be incorporated to enhance prebiotic functions or adaptogenic properties, or used to replace Tremella fuciformis at equivalent proportions, resulting in a total of 10–11 fungal components [11, 12]. The prebiotic fibers of Flammulina velutipes can support gut health and indirectly influence lipid metabolism, whereas the adaptogenic properties of Poria cocos may help alleviate stress-related metabolic disturbances.

4. Construction of a Comprehensive Nutritional Intervention Program

4.1. Three Principles of Dietary Structure Adjustment

Based on the above mechanistic analysis, nutritional intervention strategies for dogs with lipoma should follow several core principles, including weight management and caloric control. Obesity is a major modifiable risk factor for lipoma; therefore, daily energy intake should be calculated according to the dog's body condition score (BCS), with the goal of reducing BCS to the ideal range (4–5/9). Appropriate caloric restriction can lower the incidence of lipoma and extend canine lifespan. A dietary pattern emphasizing high-quality protein and low-glycemic carbohydrates is recommended [13–15]. High-starch diets are associated with lipoma development; thus, high-quality animal proteins (such as chicken, fish, and lean beef) and low-glycemic vegetables (including broccoli, spinach, and cucumber) should be prioritized as substitutes for high-starch foods (e.g., corn, wheat, and rice). In addition, functional components should be supplemented in a systematic and combined manner. Single-component interventions often show limited efficacy, whereas multi-target approaches can achieve better outcomes. For example, fish oil (anti-inflammatory and lipid-lowering), medium-chain triglycerides (metabolic reprogramming), and plant polyphenols (antioxidant and anti-adipogenic effects) can act synergistically through complementary mechanisms.

4.2. Recommended Dosages and Monitoring Indicators of Supplements

Appropriate dosing and regular monitoring are essential to ensure both safety and effectiveness of nutritional interventions. Supplement dosages should be tailored to the dog's body weight, health status, and specific metabolic needs. Key monitoring indicators include body weight, body condition score (BCS), serum lipid profiles (triglycerides, cholesterol), liver function markers, and oxidative stress indicators (such as superoxide dismutase activity). Periodic veterinary evaluation is recommended to adjust the intervention plan and optimize outcomes [16] (As shown in Table 3).

Table 3. Recommended Doses and Monitoring Indicators of Supplements

Supplemental Ingredient	Recommended Dosage	Precautions
Fish Oil (EPA + DHA)	EPA: 40–55 mg/kg body weight per day	Start with a low dose and monitor stool condition.
MCT Oil	0.5–1.0 g/kg body weight per day (divided doses)	Excessive intake may cause diarrhea.
Green Tea Extract (EGCG)	Follow product-specific instructions	Choose formulations with enhanced bioavailability.
Curcumin (Controlled-Release)	0.02%–0.03% of dietary inclusion	Co-administration with piperine or dietary fat improves absorption.

Nutritional intervention should be supported by a triad monitoring system integrating "tumor characteristics--metabolic status--laboratory parameters." Sentinel lesions should be measured every 2–4 weeks using a caliper to record the longest and perpendicular diameters, with tumor volume estimated as ≈ length × width × height × 0.52. An increase in volume of more than 30% within 4 weeks warrants referral for surgical evaluation. The 9-point body condition score (target BCS 4–5/9) should be assessed monthly, along with body weight (aiming for a 1%–2% weekly reduction during weight loss), while also monitoring muscle condition score to avoid muscle loss. Serum triglycerides and total cholesterol (reference ranges: TG < 1.0 mmol/L, TC < 5.7 mmol/L) should be evaluated every 3–6 months after 8–12 hours of fasting, with liver function tests conducted when indicated. At each assessment, whole-body palpation should be performed to document the total number of tumors and any new locations; the appearance of more than two new tumors within 6 months indicates the need for intensified intervention. It is important to clarify that the goal of nutritional intervention is to slow progression and improve metabolic status. While some lipomas may decrease in volume by approximately 10%–30%, complete regression is rare. Cases involving large size, rapid growth, or functional impairment should still be managed surgically, with nutritional strategies serving as adjunctive support [17]. A simple, structured recording form is recommended to track these indicators, along with compliance and any adverse reactions, allowing for dynamic adjustment of the intervention plan.

4.3. Compound Formula Scheme Based on Medicinal Mushrooms

The functional supplement scheme based on a compound medicinal mushroom formula aligns well with the three principles of nutritional intervention. The formulation ratio is as follows: Turkey tail mushroom 34%, Shiitake Mushroom 15%, Reishi Mushroom 13%, Lion's Mane Mushroom 9%, Maitake Mushroom 8%, Agaricus Blazei/Almond Mushroom 6%, Cordyceps Mushroom 6%, Snow Fungus Mushroom 5%, and Chaga Sclerotium Mushroom 4%. This proportion has been optimized under a patented framework (Organic Mushroom Blend for Enhanced Animal Health and Wellness Application No. 19/011176), integrating immune modulation, metabolic reprogramming, and antioxidant support, and may be adjusted according to individual needs (e.g., addition of 2–6% Enoki Mushroom and Poria Mushroom). Preliminary clinical observations showed that after three months of intervention, 70% of target lipomas had reduced in size or demonstrated slowed growth, and 12 cases exhibited softened palpation boundaries with decreased tissue tension. At six months, the maximum diameter of effective canine lipomas decreased by an average of 0.5–1.2 cm, with no new lipoma formation observed. Among secondary outcomes, 62.5% of dogs showed significant improvement in energy level, activity capacity, and daily comfort [18]. In terms of safety, only three subjects experienced transient mild gastrointestinal discomfort that resolved spontaneously, and no abnormalities were detected in hematological or biochemical parameters. Overall, these findings suggest that the patented mushroom blend, as a nutritional intervention variable, may inhibit lipoma progression through anti-inflammatory, lipid metabolism-regulating, and antioxidant mechanisms, while improving quality of life. It appears particularly suitable for geriatric dogs with poor surgical tolerance or those presenting with multiple lipomas.

5. Conclusion and Prospect

Canine lipoma is the most common benign soft tissue tumor, accounting for a large proportion in the elderly canine population. Although surgical excision remains an effective treatment, its application is often limited by the high recurrence risk and elevated anesthetic complications in geriatric dogs. Nutritional regulation-based conservative management strategies have therefore gained increasing attention, relying on the anti-inflammatory and lipid-lowering effects of omega-3 fatty acids, the metabolic reprogramming potential of medium-chain triglycerides (MCT), and the anti-adipogenic activity of plant polyphenols, providing a promising non-surgical alternative approach for lipoma management. Building upon this foundation, this study further explored the synergistic regulatory effects of a medicinal mushroom compound formula (e.g., Coriolus versicolor, Ganoderma lucidum, Lentinus edodes, white birch antler, Hericium erinaceus, Cordyceps sinensis, etc.). This formulation complements the above dietary components through multi-target mechanisms, including β-glucan-mediated immune activation, cordycepin-regulated energy metabolism, and antioxidant effects derived from white birch antler-associated polyphenols. The functional supplementation strategy constructed on this basis demonstrated preliminary clinical effects in inhibiting lipoma growth, reducing tumor volume, and improving canine vitality, with a favorable safety profile. However, several limitations remain, including the lack of standardized functional food regulations for canine applications, insufficient understanding of synergistic and antagonistic interactions among dietary components, and the absence of large-scale long-term follow-up data on nutritional interventions. Future studies should focus on multi-center randomized controlled trials to determine optimal intervention combinations and dosages, investigate the role of gut microbiota in lipid metabolism modulation under dietary influence, and develop precision nutrition strategies tailored to individual metabolic profiles in dogs. From a clinical perspective, nutritional intervention should not be considered a replacement for surgical treatment, but rather an integral component of comprehensive management. Specifically, geriatric, multiple, or surgery-intolerant dogs may benefit from nutritional regulation, while large or rapidly growing lipomas should still be managed surgically, with nutritional strategies serving as postoperative adjunctive therapy. The closed-loop system of "prevention--intervention--monitoring" may significantly improve quality of life in affected dogs while reducing both psychological stress and economic burden on pet owners.

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