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Effects of dietary flax seed and sunflower seed supplementation on normal canine serum polyunsaturated fatty acids and skin and hair coat condition scores

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Abstract This prospective study involved supplementing 18 normal dogs with flax seed (FLX) and sunflower seed (SUN) and evaluating their effects on skin and hair coat condition scores and serum polyunsaturated fatty acids (PUFA) concentrations. Skin and hair coat were evaluated in a double blinded fashion using a numeric scoring system and serum PUFA concentrations were determined. Our hypothesis was that changes in serum PUFA concentrations are associated with improvements in skin and hair coat and that serum PUFA would provide an objective method for making dietary fatty acid supplement recommendations. Although a numerical improvement was found in hair coat quality in both groups, this improvement was not sustained beyond 28 days. The relative per cent of 18:3n 3 concentrations in serum phospholipids increased in the FLX treated dogs but these concentrations remained unchanged in the SUN treated dogs. Also, elevations in relative per cent of 18:2n 6 concentrations in serum phospholipids were seen in the FLX group. The ratio of serum polyunsaturated to saturated fatty acids also showed a transient increase. These increases preceded the peak skin condition score peak value by approximately 14 days. It was concluded that a 1 month supplementation with either flax seed or sunflower seed in dogs provides temporary improvement in skin and hair coat. These changes appeared to be associated with increased serum 18 carbon PUFA.

Keywords: fatty acids, hair coat, omega 3, omega 6, seed oil, serum concentrations, skin condition, supplementation.

INTRODUCTION

Omega 3 fatty acids have recently gained popularity in the treatment of pruritic skin conditions in dogs.[1,2] These types of fatty acids are thought to produce their beneficial effects by shifting the arachidonic acid (AA) cascade towards the production of less inflammatory mediators (prostaglandins and leukotrienes).[1] Some support for this hypothesis exists in that normal dogs fed diets containing both vegetable and marine omega 3 fatty acids produced significantly less leukotriene B_4 and significantly more leukotriene B_5 compared to dogs fed diets high in omega 6 fatty acids containing no marine-based fatty acids.[3,4] One result of these cellular changes may be less inflammation of the skin and potential improvement of skin and hair coat.[1]

Other evidence for such an effect was found in a double-blinded cross over clinical study in which high dose omega 3 fatty acid supplementation from marine oils was associated with a beneficial effect.[2] Dogs with allergic dermatitis were fed high doses of omega 3 fatty acids (marine fish oil, 66 mg^{-1} kg of body weight per day). This supplementation occurred over a 6-week period and resulted in relief of pruritus and improvement of skin and hair coat.[2]

It is not known whether vegetable sources of omega 3 fatty acids such as flax seed would produce similar beneficial effects to skin and hair coat in normal dogs. Although one report had studied the effect of diets with supplements on skin and hair coat, we know of no reports which evaluate the effects of flax seed supplements (omega 3 fatty acid) in comparison to sunflower seed supplements (omega 6 fatty acid) on skin and hair coat over an extended period of time (greater than 56 days). The purpose of this study was to determine whether FLX vs. SUN supplementation under controlled conditions of total dietary fat would improve skin and hair coat

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condition scores. The possibility of an association of any improvements seen with relative changes in PUFA in serum concentrations was also examined. A skin and hair coat scoring system especially designed for this purpose was utilized and evaluated during this study.

MATERIALS AND METHODS

Animals and experimental diets

For the study, 18 adult (10 males and eight females), mixed breed dogs, 10–20 kg in body weight were used. The dogs were randomly assigned to either the sunflower or flax seed group (nine dogs each) and food was withheld overnight prior to any blood sample collections. Prior to the feeding period, the dogs were physically examined and blood samples were collected for complete blood counts, serum biochemistry profiles, and serum TT3 and TT4 concentrations. All dogs in the study were healthy and were within the normal limits for the laboratory tests. The dogs were fed a calculated amount of the diets based on their beginning body weights using the following equation: M.E. = 132 $W^{0.75}$ where M.E. is defined as metabolizable energy and the W is body weight in kilograms. The feeding periods were begun in a staggered fashion at the outset of the study so that three animals from each group (six animals per day) were started on the basal diet during the successive days of the first week. All dogs were fed the basal diet for a two week acclimation period. Immediately after this time (day 0), the dogs were fed using the same staggered feeding schedule with the basal diet now supplemented with its respective oilseed for 84 additional days. All dogs were weighed regularly during the feeding period. The skin and hair coats were considered normal for mixed breed dogs at the start of the study. However, no attempt was made to assign hair or skin condition scores until after the 2 week basal diet acclimation period. Throughout the study, all dogs were kept inside under a controlled light cycle and temperature. All of the dogs were evaluated during the same period of time during the year. Dogs were bathed as part of their routine care during the study with a nonmedicated cleansing shampoo no sooner than seven days prior to when the skin and hair coat evaluation conditioning scores were conducted. For the majority of the time a hypoallergenic moisturizing shampoo (Hylyt, DVM Pharmaceuticals, Miami, FL, USA) was used (12/18 dogs). Two dogs were bathed with an oatmeal and pramoxine shampoo (Relief, DVM Pharmaceuticals, Miami, FL, USA), two dogs were bathed with a 2% chlorhexidene shampoo (Chlorhexiderm, DVM Pharmaceuticals, Miami, FL, USA) and four dogs were bathed with an insecticidal shampoo (Mycodex 3X pyrethrins or Mycodex Carbaryl, Pet Chemicals, Memphis, TN, USA).

Flax seed and sunflower seed supplements

The whole ground flax and sunflower seeds were supplied by ENRECO (Manitowoc, WI, USA). The seeds were ground to improve digestibility and control any differences that might exist due to seed coats. A single lot number of dry Hill's Canine Senior diet (Hill's Pet Nutrition, Inc., Topeka, KS, USA) was lightly sprayed with distilled water in a bakery mixer (Hobart Industries, Troy, OH, USA) and the ground seeds were coated on the surface of the kibbled product to a final concentration of 3% on an 'as-is' basis. The diets were clearly marked for identification purposes and stored inside at 21 °C in their original bags in plastic drums with fitted lids until the time of feeding. The fatty acid compositions of these supplemented diets have been previously reported and are found in Table 1.[5]

Serum lipids

Whole blood samples were collected from all of the dogs on the study at 0, 4, 7, 14, 28, 56 and 84 days. The serum was isolated from the samples on the day of collection and aliquots subjected to total lipid extraction using the Folch procedure.[6] Serum lipids were subfractionated by thin layer chromatography on 20×20 cm silica gel G coated, 250 μm thick, glass plates (Fisher Scientific, Pittsburgh, PA, USA) developed in one dimension with hexane: ether: acetic acid (80:20:1, v/v/v) solvent. After visualization in an iodine vapour

Table 1. Fatty acid profiles of the flaxseed and sunflower seed supplemented diets (mean ± SD, average of three determination of each diet)

Fatty acid	Sunflower seed diet	Flax seed diet
14:0	0.66 ± 0.03	0.68 ± 0.03
14:1 (n 9)	0.02 ± 0.03	0.00 ± 0.00
15:0	0.03 ± 0.04	0.02 ± 0.04
16:0	16.77 ± 0.14	16.60 ± 0.31
16:1 (isomers)	0.20 ± 0.01	0.20 ± 0.01
16:(n 7)	1.90 ± 0.04	1.86 ± 0.07
17:0	0.21 ± 0.01	0.22 ± 0.01
17:1	0.16 ± 0.01	0.16 ± 0.01
18:0	6.62 ± 0.11	6.32 ± 0.07
18:1 (n 9)	28.57 ± 0.70	27.86 ± 1.09
18:1 (n 7)	1.89 ± 0.02	1.93 ± 0.05
18:2 (n 6)	37.48 ± 1.25	29.34 ± 1.17
18:3 (n 6)	0.00 ± 0.00	0.00 ± 0.00
18:3 (n 3)	1.74 ± 0.03	10.08 ± 1.18
20:0	0.33 ± 0.04	0.37 ± 0.09
20:1 (n 9)	0.42 ± 0.01	0.42 ± 0.01
20:2 (n 6)	0.18 ± 0.01	0.18 ± 0.02
20:3 (n 6)	0.07 ± 0.05	0.05 ± 0.06
20:4 (n 6)	0.57 ± 0.04	0.59 ± 0.03
20:5 (n 3)	0.11 ± 0.22	0.29 ± 0.33
22:0	0.30 ± 0.01	0.19 ± 0.01
23:0	0.04 ± 0.07	0.00 ± 0.00
22:4 (n 6)	0.12 ± 0.01	0.09 ± 0.06
22:5 (n 6)	0.03 ± 0.04	0.00 ± 0.00
22:3 (n 3)	0.01 ± 0.03	0.15 ± 0.18
24:0	0.20 ± 0.01	0.17 ± 0.01
22:6 (n 3)	0.08 ± 0.05	0.08 ± 0.05
24:1 (n 9)	0.01 ± 0.03	0.00 ± 0.00

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chamber, the phospholipid (PL) spots were marked, scraped into clean test tubes fitted with Teflon capped screw caps, and transmethylated using 4% sulphuric acid in methanol for subsequent gas chromatography.[6,7]

The resultant fatty acid methyl esters of the PL subfractions were resuspended in 30 μL hexane and 1 μL of each sample was injected onto an Omegawax 320 fused silica capillary column (0.25 μm thickness, 30 m long and 0.32 mm ID) (Supleco, Inc., Bellafonte, PA, USA) using a Hewlett Packard Series II 5890 Ga Chromatograph (Hewlett Packard Co, Palo Alto, CA, USA) with a 100: 1 split ratio, helium carrier gas with initial velocity at 30 mg min^{-1}, and temperature programming.[5] A flame ionization detector was used and results generated with a Hewlett Packard HP Chemstation software package. Fatty acid methyl ester standards (68-B, 20-A, Nu-Check Prep, Elysian, MN and fish oil standards) were used to identify the individual fatty acids via retention time comparisons. Relative concentrations of 18:2n-6 and 18:3n-3 (14C to 24 C in length) and the overall polyunsaturated and saturated (P:S) ratio of the PL fractions were tabulated and reported.

Skin and hair coat condition scores

The animals were fed their assigned supplemented diet and skin and hair coat condition scoring was conducted on days 0, 14, 28, 56 and 84 of the study. Six evaluators (two nutritionists, two dermatologists and two laboratory technicians) performed these subjective evaluations. Each evaluator was blinded as to which dog was being fed which diet. The animals were scored by the observers using the following criteria: Hair condition: 1, dull, coarse, dry; 2, poorly reflective, nonsoft; 3, medium reflective, medium soft; 4, highly reflective, very soft; 5, greasy. Skin condition: 1, dry; 2, slightly dry; 3, normal; 4, slightly greasy; 5, greasy. The skin and hair coat scoring was conducted in a veterinary examination room on a stainless steel table illuminated under an operating room examination light.

Statistical analyses

Subjective assessments of the skin and hair coat conditions of the dogs during the experimental period were statistically evaluated by repeated measures with ANOVA ($P < 0.05$). Pearson correlation coefficients were also employed to assist data interpretation.

RESULTS

Monitoring of food consumption and body weights

The dogs were observed to consume all of the food that was offered each day (range fed based on body weight, two 1/4 cups to three 1/3 cups). Body weights remained constant during the feeding period averaging 14.9 kg ± 2.9 kg SD for the SUN group and 14.6 kg ± 2.6 kg SD for the FLX at the beginning of the study and 14.5 kg ± 2.8 kg SD and 14.9 kg ± 2.9 kg SD at the end of the feeding period for SUN and FLX, respectively.

Skin and hair coat condition scores

Hair coat condition scores were initially evaluated by ANOVA which revealed a highly significant evaluator effect indicating that one or more of the evaluators were not in numerical agreement as to the starting point of the dogs in the study. Consequently, a correlation analysis (Pearson Correlation Coefficients) was conducted to examine the extent of this variability among all 18 dogs. Correlation analysis revealed that all evaluators strongly correlated with one another except for one individual. Thus, after eliminating this evaluator's scores from the data set, the ANOVA was performed again.

Analysis of hair coat condition scores revealed no significant differences between the two supplement groups when matched for time on the diets although a significant time effect overall was found (Fig. 1). Further analysis of the combined data revealed a statistically significant improvement in hair coat score on day 28 compared to day 0 but not thereafter (Fig. 1).

The ANOVA and Pearson Correlation Coefficients of the skin condition scores revealed that two evaluators did not correlate with the remaining four. Thus, these data were again analysed after eliminating the scores of these two individuals. It is noteworthy that one of these two evaluators also did not correlate with the others in regard to the hair evaluations described earlier. In the case of the skin condition scores, the ANOVA revealed no time or diet effects and no time/diet interactions. However, when differences between day 28 and other time points were analysed, a significant difference between day 14 and day 28 was seen for dogs in the FLX group (Fig. 2). This finding is also consistent with those of the hair coat evaluations noted above, in that a transient improvement was observed. It should be noted that the dogs in the FLX group entered the study at day 0 with numerically lower skin condition scores relative to those of the SUN group and this score remained low for 14 days post-supplement (Fig. 2).

To further evaluate the subjective data obtained in this study, a correlation analysis was also performed between each evaluator's skin and hair coat ratings. Three out of six evaluators' skin scores significantly correlated with their hair coat scores (*P*-values of 0.003, 0.001 and 0.0350) and three did not. Two of these latter three were also the same individuals whose scores did not correlate with the other evaluators overall. Thus it should be stressed that when multiple evaluators are used for subjective assessments, such as in this study, care should be taken to analyse the resultant data appropriately using correlation analyses and ANOVA as was performed here.

Serum phospholipid fatty acids

Increases of relative percentage of serum PL 18:3n-3 (alpha linoleic acid) were observed early in the FLX

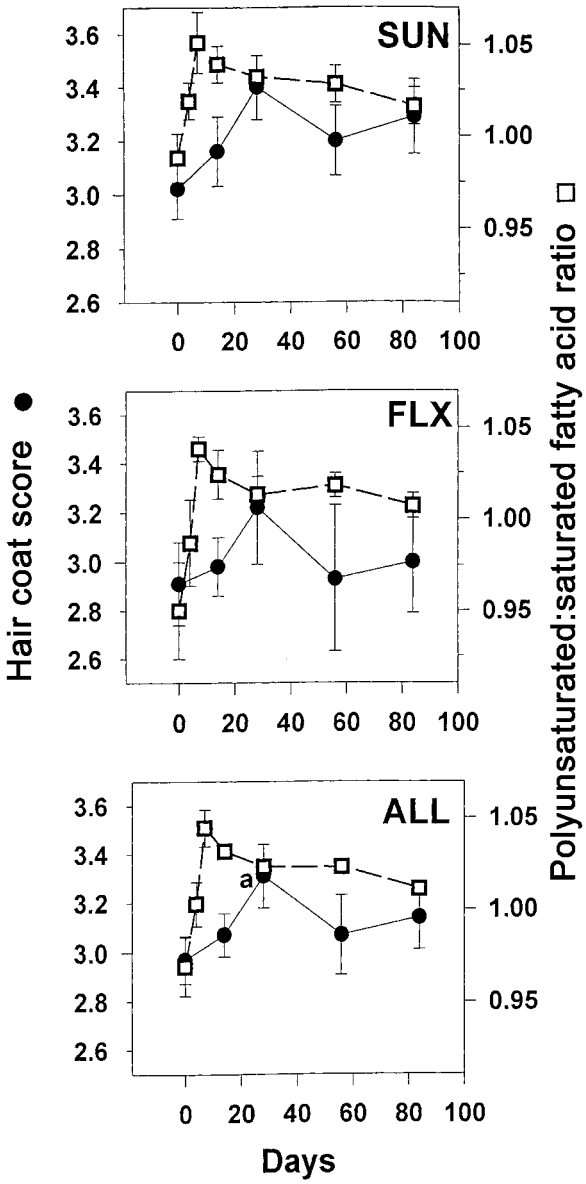

Figure 1. Hair coat scores ● and polyunsaturated: saturated fatty acid ratios □ of dogs fed sunflower seed (SUN, *n* 9) and flax seed (FLX, *n* 9) supplemented diets. All values are mean ± SE Scores for all dogs (ALL, *n* 18) are also presented; a, *P* 0.002 (day 28 vs. day 0). Time effect was significant for both hair coat score (*P* 0.003) and P:S ratio (*P* 0.001).

dogs and throughout the course of the feeding period (Fig. 3). In the SUN group, this fatty acid remained low and no changes were seen after supplementation (Fig. 3). More striking was the finding that 18:2n-6 (linoleic) in both FLX and SUN serum PL showed relative increases over time but different from one another, and a significant time effect ($P = 0.016$) throughout the feeding period, independent of the supplement type, was seen (Fig. 2). This effect was more dramatic in the FLX group with overall amounts of dietary LA numerically higher in the FLX group compared to the SUN group.

Consistent with increased LA accumulation in the PL of FLX fed dogs compared to the SUN group a significant decrease in the relative amount of 20:4n-6 (AA) was initially observed at day 28 (FLX,

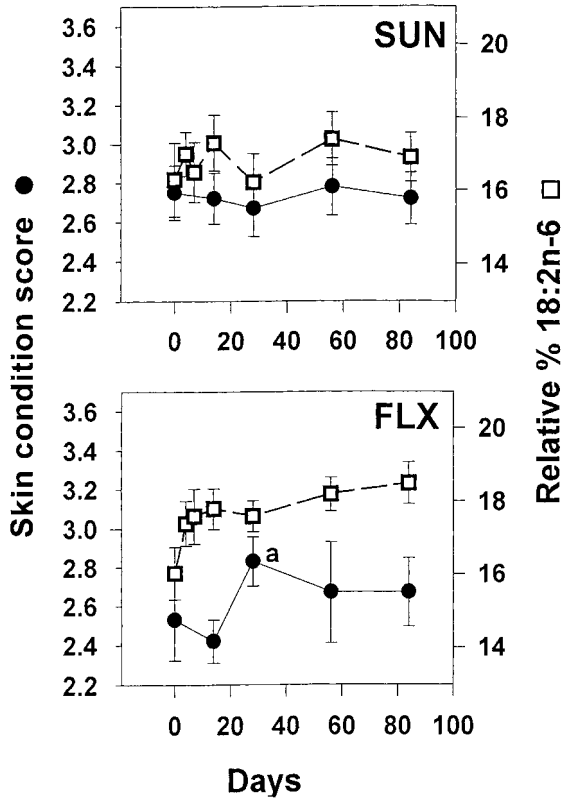

Figure 2. Skin condition scores ● and relative percentage serum phospholipid 18:2n 6 □ of dogs fed sunflower see (SUN, *n* 9) and flaxseed (FLX, *n* 9) supplemented diets. All values are mean ± SE; a, *P* 0.008 (day 28 vs. day 14). Time effect was significant for relative percentage 18:2n 6values (*P* 0.016).

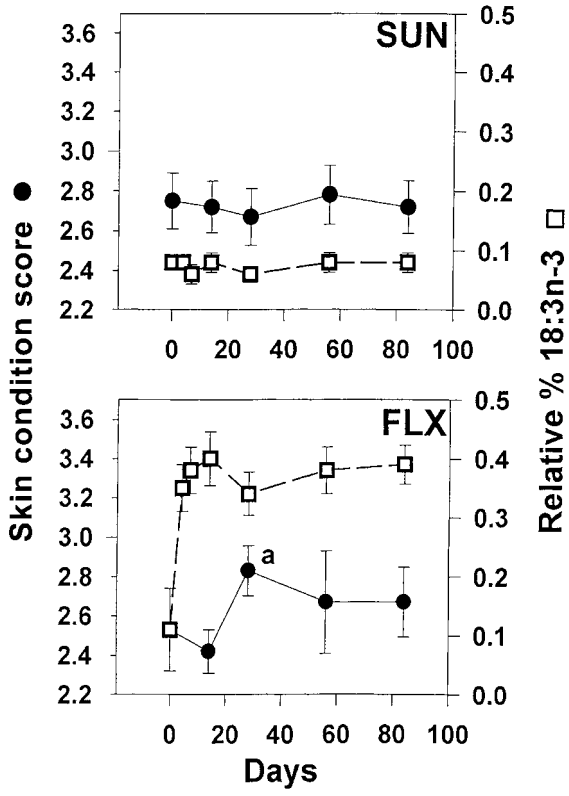

Figure 3. Skin condition scores ● and relative percentage serum phospholipid 18:3n 3 □ of dogs fed sunflower seed (SUN, *n* 9) and flaxseed (FLX, *n* 9) supplemented diets. All values are mean ± SE; a, *P* 0.008 (day 28 vs. day 14). Time effect was significant for relative percentage 18:3n 3values (*P* 0.0001).

21.1 ± 3.1 vs. SUN, 21.9 ± 3.1 on day 0: FLX, 20.0 ± 2.2 vs. SUN, 22.7 ± 2.9 on day 28, $P < 0.05$: and FLX, 19.2 ± 1.8 vs. SUN, 21.8 ± 2.6 on day 84, $P < 0.05$; all values are mean ± SD). In addition, the chain elongation product of AA, namely 22:4n-6, was also significantly decreased in FLX compared to the SUN group at these same times (FLX, 1.4 ± 0.8 vs. SUN, 1.6 ± 0.6 on day 0: FLX, 0.97 ± 0.42 vs. SUN 1.80 ± 0.71 on day 28, $P < 0.01$: and FLX, 0.80 ± 0.32 vs. SUN 2.00 ± 0.72 on day 84, $P < 0.001$; all values are mean ± SD).

Along with these n-6 fatty acid differences, significant increases in relative amounts of the long chain polyunsaturated n-3 fatty acid, 20:5n-3 (EPA), were found in the FLX group (FLX, 0.20 ± 0.11 vs. SUN, 0.14 ± 0.08 on day 0: FLX, 0.46 ± 0.26 vs. SUN, 0.15 ± 0.07 on day 28, $P < 0.01$: and FLX, 0.59 ± 0.28 vs. SUN, 0.14 ± 0.04 on day 84, $P < 0.001$; all values are mean ± SD). The chain elongation product of EPA, 22:5n-3, was also significantly decreased in FLX compared to the SUN group at these same times (FLX, 2.00 ± 0.29 vs. SUN, 1.6 ± 0.39 on day 0, $P < 0.05$: FLX, 3.20 ± 0.86 vs. SUN 1.70 ± 0.31 on day 28, $P < 0.001$: and FLX, 3.30 ± 0.93 vs. SUN 1.60 ± 0.32 on day 84, $P < 0.001$; all values are mean ± SD). However, no accumulation of 22:6n-3 was observed in either group at any time.

Consistent with the observed relative alterations of individual polyunsaturated fatty acids noted above were the overall polyunsaturated to saturated fat ratios (P:S) calculated from the PL fatty acid profiles (Fig. 1). The polyunsaturated to saturated fatty acid ratios (P/S) was calculated by dividing all polyunsaturated fatty acids identified in the fatty acid profile containing two or more double bonds by all of the saturated fatty acids containing 0 double bonds. All fatty acids from 14 to 24 carbon chain lengths, inclusive, are included in this calculation. It is customary to exclude the monounsaturated fatty acids in this calculation. This ratio is used as an index of membrane fluidity or polyunsaturated fatty acid enrichment. The P:S ratio results showed a similar trend as that seen with the hair coat scores (i.e. increase followed by a transient peak then a decrease, Fig. 1, □ for P:S ratio and ● for hair coat scores). However, it should be noted that peak P:S ratios preceded the hair condition peak values by approximately 14 days and that this phenomenon was seen in both groups. When the skin condition scores were similarly examined over the same time period (see Figs 2 and 3), the transient peak improvement was apparent in the FLX group but not in the SUN group. In addition to the P:S effects, the improvement of skin and hair coat scores appeared to be preceded by an elevation of serum PL LA.

DISCUSSION

Numerical improvement in hair coat and skin condition scores using the FLX or SUN supplemented diets were observed in this study. The improvements of hair coat scores were numerically different but significance was attained only after combining data from both the FLX and SUN groups. Although all improvements occurred soon after supplementation (28 days), they were not sustained throughout the 84 day feeding period. Thus, it appears that some adaptation to the diets may have occurred. The lack of a significant difference between FLX and SUN groups on hair coat scores suggests that either flaxseed or sunflower seed supplements may have a similar effect. The modest improvement observed in the group of dogs fed FLX on subsequent skin condition scores may be due to the fact that the FLX group skin was slightly more dry than that of the SUN group upon entry into the study.

It is noteworthy that only a modest accumulation of serum phospholipid LA occurred in the SUN group (Fig. 2). By contrast, LA accumulation in the FLX group was numerically as great and more dramatically increased when compared to the SUN group. The FLX supplement was enriched in both ALA (18:3n-3, ≈ 55%) and LA (18:2n-6, ≈ 15%) while sunflower seed, by comparison, is a richer source of linoleic acid (≈ 75%). Nonetheless, this finding suggests that ALA may have inhibited the conversion of LA to its longer chain polyunsaturated metabolites by competition for the △ 6 desaturase enzyme system thereby resulting in a more dramatic accumulation of LA when FLX was fed. Consistent with this possibility is the associated decrease of n-6 long chain PUFA, 20:4n-6 and 22:4n-6, in the FLX group.

While a direct effect of ALA acid on skin and hair coat condition cannot be ruled out from the results of this study, the possibility exists that the accumulation of LA may, at least in part, be responsible for the modest improvement of skin and hair coat scores seen. This possibility is of particular interest with regard to the well documented role that LA plays in epidermal ceramide fractions and water barrier functions compared to ALA.[8,9] Significant increases in relative amount of LA occurred when FLX was fed. This finding is especially noteworthy in view of the well documented role that LA has in overall skin health.[1,7] It is tempting to speculate that the presence of a competing dietary fatty acid such as ALA for chain desaturation and elongation may have contributed to the accumulation and possible incorporation of LA in the skin and hair follicles of dogs. In the absence of a direct measurement of △ 6 desaturase activities, this possibility cannot be determined from the results of this study. However, the fatty acid profile data of both the n-6 and n-3 PUFA do support this possibility.

It is interesting to note that the increase of serum PL P:S ratio preceded improvements in hair coat condition scores by approximately 14 days. The extent to which changes in the total amount of polyunsaturated fatty acids in the serum PL fraction

are responsible for the improvement is unknown at this time. It is generally accepted that modifications of serum lipid by dietary PUFA precedes epidermal incorporation.[9] Also, when FLX was fed, even though a decrement in n-6 PUFA was observed, at the same time increases of long chain n-3 PUFA combined to increase the total P:S ratio overall from the baseline values and supports the concept of an association between improved hair coat scores and this ratio independent of PUFA type.

The effects of oil seed supplemented diets on subjective assessments of skin and hair coat conditions observed in this study indicate that the use of either flax seed or sunflower seed supplements improve hair coat over a short time period. However, these improvements do not appear to be sustained for more than 1 month. We hypothesize that, when dietary linoleic acid is already relatively high, modest improvements in skin and hair coat scores may occur with polyunsaturated oilseed supplements enriched in either n-6 or n-3 fatty acids. One possible explanation may be that these changes are mediated by an overall increase in plasma polyunsaturated fatty acids. An alternate possibility is that the improvements reflect a total dietary fat effect rather than one specifically due to n-3 vs. n-6 polyunsaturated fat types. Long-term benefits of oilseed supplements on skin and hair coat remain to be determined.

With respect to skin condition assessments, a beneficial effect of flaxseed on skin condition was noted between 14 and 28 days. The relative percentage fatty acid alterations seen at these times suggest that LA accumulation in the serum PL, and putatively skin tissue, may help explain this observation. As a group, these dogs entered this study with somewhat less than optimal skin scores overall compared to the sunflower seed group. Thus, more noticeable improvement may have occurred in the flax seed group. This observation was made only on the two days indicated and in a relatively small sampling of normal dogs ($n = 9$). Thus, some caution should be used in interpreting this finding without additional confirmation. It may be that for those pet owners wishing to improve the skin and hair coats of their dogs for a brief period, such as in the show ring, a one month supplement using polyunsaturated fatty acid enriched sources may be useful. Studies designed to evaluate such supplements in a larger number of dogs with a wider range of both normal and abnormal skin and hair coat condition scores will be needed to confirm these possibilities.

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Résumé Cette étude prospective a inclus 18 chiens normaux, afin d'évaluer l'effet d'une supplémentation en graines de lin (FLX) ou de tournesol (SUN) sur la beauté de la peau et du pelage et sur les concentrations sériques en acides gras polyinsaturés (PUFA). La peau et le pelage étaient évalués en double aveugle par un système de score numérique, et les concentrations sériques en PUFA ont été mesurées. Nos hypothèses étaient que des modifications des concentrations sériques en PUFA soient associées à une amélioration de l'aspect de la peau et du pelage, et que le taux sérique de PUFA pourrait représenter une méthode objective pour évaluer l'intérêt d'une supplémentation en acides gras. Bien qu'une amélioration ait été observée au niveau de la qualité du pelage dans les deux groupes de chiens, cette amélioration n'existait pas plus que pendant 28 jours. Le pourcentage relatif des 18:3n 3 dans les concentrations sériques en phospholipides ont augmenté chez le chiens traités avec le FLX, mais ces concentrations n'ont pas été modifiées chez les chiens traités avec le SUN. Il a également été observé une augmentation des concentrations relatives en 18:2n 6 dans le groupe supplémenté en FLX. Le rapport des acides gras polyinsaturés et des acides gras saturés a également montré une augmentation transitoire. Ces augmentations précédaient le pic d'amélioration clinique d'environ 14 jours. Il a été conclu qu'une supplémentation d'un mois avec des graines de lin ou de tournesol permet une

amélioration transitoire de l'aspect de la peau et du pelage chez le chien. Ces modifications semblent être associées à une augmentation des taux sériques de PUFA de la série 18. [Rees, C. A., Bauer, J. E., Burkholder, W. J., Kennis, R. A., Dunbar B. L., Bigley, K. E. Effects of dietary flax seed and sunflower seed supplementation on normal canine serum polyunsaturated fatty acids and skin and hair coat condition scores. (Effets de la supplémentation alimentaire en graines de lins ou de tournesol sur les taux sériques d'acides gras polyinsaturés et sur la beauté du poil et de la peau.) *Veterinary Dermatology* 2001; **12:** 111 117.]

Resumen Este estudio prospectivo consistió en la suplementación de 18 perros normales con semilla de lino (FLX) y semilla de girasol (SUN) y la evaluación de sus efectos sobre la puntuación del estado de la piel y el pelaje y las concentraciones séricas de ácidos grasos poli insaturados (PUFA). La piel y el pelaje fueron evaluados de forma doble ciego utilizando un sistema de puntuación numérica y se determinaron las concentraciones séricas de PUFA. Nuestra hipótesis fue que los cambios en las concentraciones séricas de PUFA están asociadas a mejorías en la piel y el pelaje y que el PUFA sérico proporcionaría un método objetivo para emitir recomendaciones sobre los ácidos grasos de la dieta. A pesar de que se observó una mejoría numérica en la calidad del pelaje en ambos grupos, esta mejoría no se mantuvo más allá de 28 días. El porcentaje relativo de las concentraciones de 18:3n 3 en fosfolípidos séricos incrementaron en los perros tratados con FLX pero estas concentraciones no se alteraron en los perros tratados con SUN. También se observó una elevación en el porcentaje relativo de las concentraciones de 18:2n 6 en fosfolípidos séricos en el grupo FLX. El índice de ácidos grasos poli insaturados respecto a saturados también mostró un incremento transitorio. Estos incrementos precedieron el pico de puntuación de la condición cutánea, en aproximadamente 14 días. Se concluyó que la suplementación durante 1 mes con semilla de lino o con semilla de girasol en perros proporciona una mejoría temporal del pelaje. Estos cambios parecieron estar asociados a un incremento sérico en carbono 18 PUFA. [Rees, C. A., Bauer, J. E., Burkholder, W. J., Kennis, R. A., Dunbar B. L., Bigley, K. E. Effects of dietary flax seed and sunflower seed supplementation on normal canine serum polyunsaturated fatty acids and skin and hair coat condition scores. (Efectos de la suple mentación con semilla de lino y semilla de girasol sobre los ácidos grasos poli insaturados séricos de perros normales y la puntuación sobre el estado de la piel y del pelaje.) *Veterinary Dermatology* 2001; **12:** 111 117.]

Zusammenfassung In dieser prospektiven Studie wurden 18 normale Hunde mit Leinsamenöl (LSÖ) und Sonnenblumenkernöl (SBÖ) supplementiert und deren Effekt auf Haut und Haarkleid bewertet und mehrfach ungesättigte Fettsäuren (MUFS) im Serum gemessen. Haut und Haarkleid wurden mittels eines numerischen Doppelblindbewertungssystems beurteilt. Unsere Hypothese war, dass Änderungen in der Konzentration von MUFS mit Verbesserung von Haut und Haarkleid einhergehen und dass Serumkonzentrationen von MUFS als objektive Basis zur Empfehlung von Fettsäurensupplementierung dienen könnten. Obwohl eine numerische Besserung des Haarkleides in beiden Gruppen festzustellen war, konnte diese Besserung nicht länger als 28 Tage erhalten werden. Der relative Prozentsatz von 18:3n 3 Konzentrationen der Serumphospholipide vergrösserte sich bei Hunden, die mit LSÖ behandelt wurden, diese Konzentrationen waren allerdings in den mit SBÖ behandelten Hunden unverändert. Ein erhöhter relativer Prozentsatz von 18:2n 6 Konzentrationen in Serumphospholipiden wurde in der LSÖ Gruppe ebenfalls gesehen. Das Verhältnis von mehrfach ungesättigten zu gesättigten Fettsäuren erhöhte sich ebenfalls vorübergehend. Diese Erhöhungen gingen dem Höchststand der Hautzustandswerte um 14 Tage voraus. Eine einmonatige Supplementierung mit LSÖ oder SBÖ führt zu einer zeitweiligen Besserung von Haut und Haarkleid. Diese Änderungen scheinen mit erhöhten Serumwerten von MUFS mit 18 Kohlenstoffatomen einherzugehen. [Rees, C. A., Bauer, J. E., Burkholder, W. J., Kennis, R. A., Dunbar B. L., Bigley, K. E. Effects of dietary flax seed and sunflower seed supplementation on normal canine serum polyunsaturated fatty acids and skin and hair coat condition scores. (Die Wirkung von Leinsamenöl und Sonnenblumenkernölsupplementierung auf mehrfach ungesättigte Fettsäuren im Serum normaler Hunde und auf den Zustand von Haut und Haarkleid.) *Veterinary Dermatology* 2001; **12:** 111 117.]