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Evaluation of graded levels of corn-fermented protein on stool quality, apparent nutrient digestibility, and palatability in healthy adult cats

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Abstract

Dried distillers' grains, coproducts from the ethanol industry, may provide sustainable ingredients for pet food. Due to new post-fermentation separation techniques, corn-fermented protein (**CFP**) is higher in protein and lower in fiber compared with traditional dried distillers' grains, increasing its appeal for inclusion into pet food. Therefore, the objectives of this study were to determine the effects of increasing levels of CFP on stool quality, apparent total tract digestibility (**ATTD**), and palatability in adult cats. Four extruded diets were fed to 11 adult cats in an incomplete 4 × 4 replicated Latin square design. The control diet contained 15% soybean meal (0C) and CFP was exchanged for soybean meal at either 5%, 10%, or 15% (5C, 10C, 15C). Cats were fed each dietary treatment for 9-d adaption followed by 5-d total fecal collection. Feces were scored on a 1 to 5 scale, with 1 representing liquid diarrhea and 5 representing hard pellet-like (Carciofi et al., 2008). A fecal score of 3.5 to 4 was considered ideal. Titanium dioxide was added to all diets (0.4%) as a marker to estimate digestibility. Data were analyzed using a mixed model in SAS (version 9.4, SAS Institute, Inc., Cary, NC) with treatment as a fixed effect and cat and period as random effects. Fecal dry matter percent and dry fecal output were greater ($P < 0.05$) at elevated levels of CFP. Stool scores were maintained ($P > 0.05$) throughout treatments (average; 4). Dry matter, organic matter, crude protein, and gross energy ATTD decreased when cats were fed 15C. There was no difference in ATTD of fat or total dietary fiber among treatments. For palatability assessment, cats preferred 5C over 0C but had no preference with increased CFP inclusion. These results suggest that CFP is comparable to SBM, but there may be a maximum inclusion level of 10% when fed to cats.

LAY SUMMARY

Sustainable ingredients are of increasing demand within the pet food industry. Corn-fermented protein (**CFP**) could provide a sustainable protein source for pet food. CFP is a coproduct from ethanol production, which is produced using post-fermentation separation technology to create a high-protein, low-fiber ingredient. In this work, 11 healthy cats were fed diets containing 0%, 5%, 10%, and 15% CFP in exchange for soybean meal. Cats were fed each dietary treatment for 14 d with a 9-d adaptation phase followed by a 5-d total fecal collection. Stool quality and diet digestibility were analyzed. Total fecal output of cats increased, and diet digestibility decreased with the 15% CFP inclusion. These results are likely due to the fiber component of CFP indicating a maximum inclusion level at 10% when fed to cats. In addition, palatability of diets was evaluated at a commercial kennel and proved to be acceptable at all CFP inclusion levels when fed to cats. Further research is needed to evaluate the possible impact of CFP on animal health when included in pet food.

Key words: corn-fermented protein, feline, nutrient digestibility, palatability

Abbreviations: DM, dry matter; AAFCO, Association of American Feed Control Officials; DDGS, distiller's dried grains with solubles; CFP, corn-fermented protein; IACUC, Institutional Animal Care and Use Committee; SBM, soybean meal; TiO_2, titanium dioxide; ATTD, apparent total tract digestibility; OM, organic matter; CP, crude protein; TDF, total dietary fiber; GE, gross energy

Introduction

Sustainability has become a demand in all industries as the overuse of resources has become a concern (Global Sustainability Study, 2021). The global pet food market is valued at almost $95 billion dollars annually and is expected to continue growing (Pet Food Market Size, Share &Trends Analysis Report, 2021). Due to its substantial size, a shift in the pet food industry to more sustainable products and production systems could have a significant impact. However, optimizing the sustainability of pet food is challenging as they are often formulated to exceed nutrient requirements, use ingredients that compete directly with the human food supply, and (or) are overconsumed by pets resulting in food wastage (Swanson et al., 2013).

The primary concerns regarding sustainability within the pet food industry are ingredient selection and nutrient composition (Swanson et al., 2013; Acuff et al., 2021). Specifically, protein is the most expensive and ecologically demanding macronutrient (Nijdam et al., 2012; Berardy et al., 2019). However, protein source and inclusion level are key drivers for pet owner selection of pet food (Acuff et al., 2021). Therefore, pet foods are often formulated to exceed nutritional requirements for protein and may contain protein sources, which directly compete with the human food supply. On average, commercially available dry dog and cat foods contain 31% crude protein (dry matter [**DM**] basis; Hill et al., 2009), which exceeds the minimum recommendations set by

the Association of American Feed Control Officials (**AAFCO**) at 18% for adult dogs and 26% for adult cats (DM basis). In addition, meat or muscle tissue is perceived by pet owners to be of higher nutritional quality for dogs and cats compared with protein coproducts with animal-based sources preferred over plant-based sources (Okin, 2017; Association for Pet Obesity Prevention, 2018). However, crude protein digestibility, corrected for endogenous losses, of both sources has been reported to be similar when fed to dogs and cats (Golder et al., 2020). The amino acid profile of plant-based sources can meet that of animal-based proteins with the use of complementary ingredients (Li and Wu, 2020). Of note, taurine concentration must be especially considered with increased inclusion of plant-based protein sources. Substitution of meat for plant-based coproducts could support environmental and economic sustainability by using fewer natural resources and providing competitively priced alternatives resulting in a smaller carbon footprint (Knight and Leitsberger, 2016; Acuff et al., 2021).

Specifically, distiller's dried grains with solubles (**DDGS**), a major coproduct from ethanol production, may be of interest. These DDGS have commonly been included in livestock feed due to their moderate levels of protein, fat, and fiber (Lodge et al., 1997; Batal and Dale, 2006). Previous studies have supported the use of conventional DDGS in pet food (Allen et al., 1981; Silva et al., 2016). However, the use of coproduct ingredients in pet food has been limited due to consumer perception. Therefore, ethanol companies are developing new techniques to enhance the nutritional composition for use in pet food. These enhanced products are produced using post-fermentation separation technologies to split the protein and yeast from the fiber prior to drying. Therefore, they are higher in protein and lower in fiber compared to traditional DDGS, which should increase their appeal for inclusion into pet food. One of these enhanced protein sources has already been evaluated in pet food and was reported to have comparable digestibility and palatability to soybean meal when fed to dogs (Smith and Aldrich, 2022). Based on this study, further research is needed to determine the optimum inclusion level in pet foods. Therefore, the objective of this study was to evaluate increasing levels of corn-fermented protein (**CFP**) on stool quality, nutrient digestibility, and palatability when fed to adult cats.

Materials and Methods

The feeding trial was conducted at Kansas State University Veterinary Medicine Complex (Coles Hall) under the Institutional Animal Care and Use Committee (IACUC) #4348 protocol. The palatability trial was conducted at Summit Ridge Farms (Susquehanna, PA) under protocols KSUPALF00420, KSUPALF00520, and KSUPALF00620.

Diet formulation and production

Four different diets with increasing levels of CFP (POET Bioproducts, Sioux Falls, SD), as a replacement for equal levels of soybean meal (**SBM**; Fairview Mills, Seneca, KS), were formulated. Soybean meal was chosen as the control protein source due to a previous study, which reported similar digestibility of SBM and CFP when fed to dogs (Smith and Aldrich, 2022). In addition, the protein content of CFP is comparable to SBM. The analyzed chemical composition of experimental ingredients, SBM and CFP, are presented

in Table 1. The control diet contained 15% SBM (0C) and CFP was exchanged at either 5% (5C), 10% (10C), or 15% (15C) for the SBM. The formulated diets met the AAFCO nutritional requirements of healthy adult cats. Titanium dioxide (0.40%) was added to serve as an indigestible marker to estimate apparent total tract nutrient digestibility. The dry raw materials, except for the CFP, SBM, and titanium dioxide, comprised the dry base ration and were purchased from a commercial mill (Fairview Mills, Seneca, KS; Table 2).

Each diet was mixed and produced using a single screw extruder (model E525, Extru-Tech, Manhattan, KS). The cool and dry product was packaged in laminated bags and transferred to the laboratory at Kansas State University to be coated. Kibbles were coated with chicken fat protected with natural antioxidants and a dry powdered flavor designed for cats. Coated diets were stored in poly-lined Kraft paper bags until fed.

Feeding trial

Eleven healthy adult (3.1 ± 1.7 yr) American shorthair cats (10 males and 1 female) were enrolled in this study. The cats had an average body weight of 5.6 ± 1.7 kg, and food allowance was controlled to maintain their weight throughout the study. The daily metabolizable energy requirement was calculated for lean cats with $100 \ast BW_{kg}^{0.67}$ (NRC, 2006). The body weight of cats was measured at the beginning, middle, and end of each period. The study was conducted as an incomplete replicated Latin square design. Each of the four periods were composed of 9 d for adaptation followed by 5 d of collection. In this model, each animal served as its own control, and each treatment had 11 total observations.

The cats were housed on a 12 h light cycle with lights off from 1900 to 0700. In the adaption period, the cats were group-housed but fed individually. Whereas in the collection period, the cats were individually housed in stainless steel cages. The cats received two feedings per day at 0700 and 1600 h with access to food for 1 h and water ad libitum. In case a cat refused to eat an experimental diet, an additional 0.5% to 1.0% flavor enhancer was added topically to the food. During the collection period, all feces and orts were collected daily. The fecal samples were weighed and scored on a 1 to 5 scale with 0.5 increments [1—liquid diarrhea to 5—dry hard pellets; Carciofi et al., 2008]. A score of 3.5 to 4.0 was considered ideal. In addition, the pH of a fresh fecal sample (within 15 min of defecation) was recorded in triplicate with a calibrated glass-electrode pH probe (FC240B,

Table 1. Analyzed chemical composition of experimental ingredients, soybean meal (SBM) and corn-fermented protein (CFP), reported on a dry matter basis

Nutrient, %	SBM	CFP
Moisture	11.97	5.13
Ash	8.14	2.84
Protein	53.44	52.62
Fat	2.71	5.60
Insoluble dietary fiber	16.36	31.41
Soluble dietary fiber	3.52	3.58
Total dietary fiber	19.88	34.89

Table 2. Ingredient composition of feline diets with increasing levels of corn-fermented protein

Ingredient, %	Treatment[1]			
	0C	5C	10C	15C
Corn	37.97	38.11	38.26	38.41
Chicken meal	20.86	20.23	19.59	18.96
Chicken meal, low ash	11.11	11.72	12.33	12.95
Soybean meal	15.00	10.00	5.00	—
Corn-fermented protein	—	5.00	10.00	15.00
Chicken fat	5.65	5.52	5.40	5.27
Beet pulp	4.00	4.00	4.00	4.00
Fish meal	3.00	3.00	3.00	3.00
Flavor	1.00	1.00	1.00	1.00
Titanium dioxide	0.40	0.40	0.40	0.40
Salt	0.25	0.25	0.25	0.25
Potassium chloride	0.25	0.25	0.25	0.25
Vitamin and mineral premix	0.25	0.25	0.25	0.25
Choline chloride, 60% dry	0.20	0.20	0.20	0.20
Natural antioxidant	0.07	0.07	0.07	0.07

[1]0C, 0% corn-fermented protein; 5C, 5% corn-fermented protein; 10C, 10% corn-fermented protein; 15C, 15% corn-fermented protein.

Hanna Instruments, Smithfield, RI). Fecal samples were stored in labeled whirl-pak bags in a freezer until further processed. The orts were dried and weighed to compute daily food intake.

Digestibility calculations

After each collection period, feces from each cat were composited and dried at 55°C in a forced air oven until constant weight (24 to 48 h). Dried samples were ground to pass through a 1 mm screen in a laboratory fixed blade impact mill (ZM 200, Retsch, Verder Scientific, Haan, Germany). Titanium dioxide concentration was measured in food and feces using a spectrophotometric plate reader (Gen5TM, Biotek Instruments, Inc.Winooski, VT) at 410 nm (Myers et al., 2004). Apparent total tract digestibility (**ATTD**) was estimated by titanium dioxide using the following equation:

$$\text{ATTD} = \left[1 - \frac{\% \text{ TiO}_2 \text{ in food} * \% \text{ nutrient in feces}}{\% \text{ TiO}_2 \text{ in feces} * \% \text{ nutrient in food}}\right] * 100$$

Digestibility was calculated using both the total collection and titanium dioxide methods, which resulted in similar digestibility values and trends. However, the titanium dioxide method resulted in a lower standard error of the mean. Therefore, digestibility values from the titanium dioxide method were selected to report in this manuscript.

Nutrient analysis

Food and partially dried fecal samples were analyzed in duplicate for moisture (AOAC 930.15), ash (AOAC 942.05), fat by acid hydrolysis and hexane extraction (AOAC 960.39), gross energy (Parr 6200 Calorimeter, Parr Instrument Company, Moline, IL), and total dietary fiber (AOAC 991.43). Crude protein was determined by Dumas combustion (AOAC 990.03) using a nitrogen analyzer (FP928, LECO Corporation, Saint Joseph, MI).

Palatability trial

Experimental treatments (5C, 10C, and 15C) were evaluated for palatability vs. the control diet (0C) by cat panels at a commercial kennel (Summit Ridge Farms, Susquehanna, PA). Each experiment was conducted as a split-plate test, in which two stainless steel bowls containing 100 g of food were presented to animals for a total of 4 h. Each comparison trial was repeated for 2 d, with bowl position switched daily. Twenty animals were fed daily, providing 40 observations for each paired comparison test. Preference was determined based on animals' first choice and total food consumption. Data from consumption were represented as the following ratio:

$$\text{Intake ratio} = \left(\frac{\text{consumption of Diet A}}{\text{total consumption Diet A} + \text{Diet B}}\right)$$

Statistics

The digestibility experiment was conducted as an incomplete 4 × 4 replicated Latin square design. Each of the 11 experimental units (cats) were assigned to treatment using the spreadsheet by Kim and Stein (2009). Data were analyzed using a GLIMMIX procedure in SAS (version 9.4, SAS Institute, Inc., Cary, NC) with treatment as a fixed effect and cat and period as random effects. Tukey's post hoc test was applied for the least-squares means separation, with significance considered at $P < 0.05$.

In the palatability experiment, the consumption ratio was analyzed using a t-test in a two-way ANOVA, and the first-choice preference was analyzed using a χ^2 test. The 20 cats were considered the experimental units for analysis.

Results and discussion

Diet chemical analyses

During production experimental diets were dried to around 5% moisture. On a DM basis, the experimental treatments were approximately 91% organic matter (**OM**), 36% crude protein (**CP**), 13% fat, and 4918 kcal/kg gross energy (Table 3). The total dietary fiber (**TDF**) ranged from 16.1% in the 15C to 13.8% in the 0C. This would be expected as the experimental ingredients, SBM and CFP, have similar protein content (53.4% and 52.6%, respectively), but CFP contained 34.9% TDF while SBM contained 19.9% TDF (Table 1). Therefore, it would be expected that as CFP replaced SBM that TDF of the diets would rise accordingly.

Feed intake and fecal characteristics

Feed intake was not different ($P > 0.05$) among dietary treatments at an average of 72.9 g/d (Table 4). This was to be expected as food intake was controlled to maintain body weight. In addition, there were no significant feed refusals among dietary treatments and cats consumed the diets readily. Fecal DM percent was greater for cats fed the 10C and 15C treatments (33.2% and 32.8%, respectively) compared with the 0C treatment at 30.7% ($P < 0.05$), while the 5C treatment was intermediate at 32.1% (Table 4). Allen et al. (1981) reported an increase in fecal DM percent for dogs fed a diet containing 15.7% DDGS relative to dogs fed a diet containing 0% DDGS. However, in their study, there was no difference in fecal DM percent for dogs fed diets containing up to 8.9% DDGS. Dry fecal output was greater for cats fed the

Table 3. Analyzed chemical composition of feline diets with increasing levels of corn-fermented protein reported on a dry matter basis

Nutrient	Treatment[1]			
	0C	5C	10C	15C
Dry matter, %	95.24	95.76	95.09	94.65
Moisture, %	4.76	4.24	4.91	5.35
Organic matter, %	90.81	90.72	91.20	91.63
Ash, %	9.19	9.28	8.80	8.37
Crude protein, %	35.35	36.32	36.24	36.72
Fat, %	12.16	12.96	12.56	12.66
Gross energy, kcal/kg	4,854.66	4,915.26	4,932.77	4,969.45
Insoluble dietary fiber, %	11.01	10.75	11.55	12.95
Soluble dietary fiber, %	2.65	3.35	2.45	3.19
Total dietary fiber, %	13.76	14.20	14.00	16.13

[1]0C, 0% corn-fermented protein; 5C, 5% corn-fermented protein; 10C, 10% corn-fermented protein; 15C, 15% corn-fermented protein.

Table 4. Food intake and stool quality parameters of cats fed diets with increasing levels of corn-fermented protein

Parameter	Treatment[1]				SEM	*P*-value
	0C	5C	10C	15C		
Food intake, g/d	69.67	72.04	74.61	75.11	2.145	0.0616
Wet fecal output, g/d	41.98	41.66	43.74	48.39	2.57	0.0523
Fecal dry matter, %	30.73[b]	32.08[a,b]	33.22[a]	32.80[a]	0.565	0.0009
Dry fecal output, g/d	12.69[b]	13.29[b]	14.54[a,b]	15.77[a]	0.744	0.0015
Defecations per day	0.83	0.83	0.83	0.92	0.046	0.1279
Fecal score	3.96	4.03	4.09	4.00	0.083	0.4617
Fecal pH	5.45[a]	5.45[a]	5.26[b]	5.41[a]	0.052	0.0027

[1]0C, 0% corn-fermented protein; 5C, 5% corn-fermented protein; 10C, 10% corn-fermented protein; 15C, 15% corn-fermented protein.
[a-b]Means within a row lacking a common superscript letter are different (*P* < 0.05).

15C treatment (15.8 g/d) than those fed the 0C and 5C treatments (12.7 and 13.3 g/d, respectively; *P* < 0.05). Dry fecal output of cats consuming the 10C treatment was intermediate at 14.5 g/d. The increase in fecal output with the 15% inclusion is likely due to the increased fiber content of the diet. Yamka et al. (2003) reported that an increase in dietary fiber may result in decreased digestion and greater fecal mass due to an increased rate of passage through the digestive system and decreased absorption. Likewise, Smith and Aldrich (2022) reported an increase in dry fecal output for dogs consuming a diet containing 25% CFP compared with SBM. Fecal defecation of cats was similar among dietary treatments at an average of 0.85 times per day (*P* > 0.05). Fecal score was not impacted (*P* > 0.05) by dietary treatment with an average of 4.0, which was considered near ideal (Table 4). Smith and Aldrich (2022) also reported no differences in fecal defecation or fecal score among dogs consuming diets containing CFP or SBM. Fecal pH was lowest (*P* < 0.05) for cats consuming the

Table 5. Apparent total tract digestibility of cats fed diets with increasing levels of corn-fermented protein estimated by TiO_2 as a dietary marker

Nutrient, %	Treatment[1]				SEM	*P*-value
	0C	5C	10C	15C		
Dry matter	80.63[a]	80.14[a]	80.71[a]	78.88[b]	0.342	<0.0001
Organic matter	85.83[a]	85.44[a]	85.61[a]	83.94[b]	0.286	<0.0001
Crude protein	87.04[a]	86.60[a]	86.85[a]	85.39[b]	0.340	0.0002
Fat	95.81	95.91	96.17	95.56	0.266	0.1661
Total dietary fiber	47.60	49.54	47.90	49.81	1.160	0.1499
Gross energy	86.03[a]	85.78[a]	85.88[a]	84.18[b]	0.285	<0.0001

[1]0C, 0% corn-fermented protein; 5C, 5% corn-fermented protein; 10C, 10% corn-fermented protein; 15C, 15% corn-fermented protein.
[a,b]Means within a row lacking a common superscript letter are different (*P* < 0.05).

10C treatment. This result was interesting as differences were expected for the 15C treatment rather than the 10C treatment as previous studies reported increased fiber intake associated with lower fecal pH (Faruk et al., 2018).

Apparent total tract digestibility

Cats fed the 0C, 5C, and 10C treatments resulted in a greater DM digestibility (80.6%, 80.1%, and 80.7%, respectively) compared with those fed the 15C treatment (78.9%; Table 5). A previous study reported a similar DM digestibility of 79.9% for a diet containing 15.7% DDGS when fed to dogs (Allen et al., 1981). In addition, Allen et al. (1981) reported a decrease in DM digestibility when dogs were fed the 15.7% DDGS treatment but no difference with up to 8.9% DDGS inclusion when compared to a control. The OM digestibility was lowest (*P* < 0.05) for cats fed the 15C treatment. The CP digestibility was greater for cats fed the 0C, 5C, and 10C treatments (87.0%, 86.6%, and 86.9%, respectively) when compared with the 15C treatment (85.4%). Silva et al. (2016) reported a similar CP digestibility at 85% with an 18% DDGS inclusion fed to dogs. Gross energy (**GE**) digestibility followed the same trend with 15C reporting a lower value at 84.2% compared with the remaining treatments. The decrease in digestibility by cats fed the 15C treatment is likely due to the increased fiber content. Previous studies have reported a decrease in nutrient digestibility with increased fiber inclusion fed to cats (Sunvold et al., 1995; Fischer et al., 2012). Smith and Aldrich (2022) also reported a decrease in DM, OM, and GE digestibility when dogs were fed a diet containing 25% CFP compared to SBM. However, in the current study, fat and TDF digestibility were not affected by CFP inclusion (*P* > 0.05; Table 5). Overall, cats fed the 15C treatment resulted in approximately 1.5%-unit lower digestibility when compared to those fed the 0C, 5C, or 10C treatments. Therefore, there appears to be a threshold between 10% and 15% CFP inclusion at which diet digestibility, likely due to the fiber content, is impacted when fed to cats.

Conversely, it is important to consider the possible health benefits that CFP could provide for companion animals, specifically its fiber component. The roles dietary fiber play in overall health can be split into the soluble and insoluble fractions. Soluble fiber has been reported to decrease gastric emptying, increase satiety, reduce rate of glucose uptake, lower blood cholesterol, and provide substrate for beneficial microbe growth in the digestive system (German et al., 1996;

Table 6. First choice (FC) and intake ratio (IR) of cats fed diets with increasing levels of corn-fermented protein

Diet comparison (A vs. B)[1]	FC[2]	IR[3]
5C vs. 0C	30*	0.970*
10C vs. 0C	18	0.538
15C vs. 0C	19	0.590

[1]0C, 0% corn-fermented protein; 5C, 5% corn-fermented protein; 10C, 10% corn-fermented protein; 15C, 15% corn-fermented protein.
[2]Number of first visits to bowl A out of 40 observations.
[3]IR = intake (g) of diet A/total intake (g) of diets A+B.
*Comparison differs ($P < 0.05$).

Tungland, 2003; Brennan and Cleary, 2005; Jenkins et al., 2008). While insoluble dietary fiber has been described to decrease gastric transit time, dilute caloric density of diets, increase fecal bulk and moisture, and aid in laxation (Wenk, 2001). In terms of its fiber composition, CFP would likely be best utilized in a weight management diet as it contains 31.4% insoluble dietary fiber and 3.6% soluble dietary fiber (Table 1). An in vitro study reported that a novel corn fiber acted as an insoluble fiber and may be a good replacement for Solka-Floc, a common ingredient used for laxation and body weight control in pet food (de Godoy et al., 2009). In addition, the phenolic compounds in corn could provide additional health benefits such as reducing the risk of colon cancer and providing an antioxidant effect (Adom and Liu, 2002). Therefore, CFP is a unique ingredient as it could be included in pet food as a protein source at moderate levels (≤10%) without altering digestibility, but also to support animal health at higher levels.

Palatability

In first choice evaluation, cats chose the 5C treatment first over the 0C treatment 30 of 40 times ($P < 0.05$; Table 6). In addition, cats consumed significantly more of the 5C treatment compared with the 0C treatment with an intake ratio of 0.97. These results indicate that cats preferred the 5C treatment over the 0C treatment. This preference could be due to the yeast component of CFP. Previous studies have reported that yeast, likely due to the nucleotides, is highly palatable to cats (White and Boudreau, 1975; Swanson and Fahey, 2004). However, there was no preference between the 10C or the 15C treatments when compared to the 0C treatment as first choice and consumption of the CFP diets were almost equal to the 0C. These results were surprising as it was expected that increased yeast with each dose would improve palatability. Smith and Aldrich (2022) observed similar results in which cats appeared to have no preference when comparing a diet containing 25% CFP to a diet containing SBM. These results imply that there may be a maximum inclusion level of CFP for increased palatability. Of note, the palatability of the 10% and 15% inclusion was still well accepted by cats and comparable to a diet containing SBM.

Summary

The starch in corn is converted to ethanol during fermentation, resulting in coproducts containing increased levels of protein and fiber. Furthermore, post-fermentation technologies, in which CFP is produced, further elevates the protein content but decreases the fiber content. The evaluation of CFP in pet food warrants further investigation as the phenolic compounds in corn may provide further health benefits in addition to its role as an insoluble fiber. Therefore, inclusion levels of CFP may vary depending upon marketing, diet digestibility, and animal health goals. A limitation of this study was the narrow scope of the work which could be expanded in future studies to evaluate the fiber component of CFP on overall health when fed to cats. In addition, further work is needed to elucidate the components of CFP (fiber vs yeast) to have a better understanding of ingredient functionality.

Conclusion

In conclusion, CFP could provide a novel protein source for pet food based on acceptable stool quality, digestibility, and palatability when fed to cats. However, if the goal of inclusion is to maintain these parameters when compared with a control diet containing SBM, there appears to be a maximum inclusion level of CFP at 10% due to its increased fiber content.

Acknowledgments

Conflict of Interest Statement

The authors declare no conflict of interest.

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