



Nutritional Composition, Microbiological Findings, and Short-Term Acceptance of Experimental Dog-Food Formulations Containing Mongolian Horse Liver and Lung

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Abstract

The utilization of livestock by-products in pet food production may improve resource efficiency while providing alternative animal-derived ingredients. This preliminary study characterized the proximate composition and selected mineral concentrations of hot-air-dried Mongolian horse liver and lung and summarized source-record data on experimental formulations, microbiological findings, feeding acceptance, and two-bowl preference. Liver and lung were dried at 50°C or 70°C for 24 h, using 5 kg per batch and three independently prepared batches per organ-temperature condition, then ground through an approximately 1 mm screen. A prototype containing 90% dried organ, 2.5% corn, 2.5% peas, and 5% oil was selected for further evaluation. Source-record crude protein concentrations were 32.01% in the liver-based formulation and 31.60% in the lung-based formulation. Total bacterial counts were reported as 3.0×10^2 and 2.0×10^2 CFU/g, respectively; *Escherichia coli*, molds/fungi, and *Salmonella* were reported as not detected in the tested samples. In a 10-dog feeding assessment, short-term intake was similar in magnitude between the test and commercial comparator foods. In a two-bowl assessment, the test food accounted for 60% of first-choice observations, while the descriptive intake ratio calculated from group mean intakes was 2.76. These values are reported from archived source records; replicate-level analytical data and complete raw datasets were unavailable for independent verification. Raw-material traceability, some drying and AAS instrument details, complete microbiological methods, the identity and composition of the comparator, and final-product processing and storage conditions were also incompletely documented. The reported composition does not provide a complete mass balance. The findings are therefore preliminary and descriptive and do not establish complete-diet adequacy, validated metabolizable energy, statistically significant preference, comprehensive microbiological safety, or shelf-life stability.

Keywords: Mongolian Horse; Horse Liver; Horse Lung; Animal By-Products; Experimental Dog-Food Formulation; Hot-Air Drying; Short-Term Acceptance; Microbiological Quality

Introduction

The pet food sector increasingly emphasizes ingredient quality, nutritional adequacy, palatability, safety, and environmental performance. Animal-derived ingredients remain important in canine diets because they can provide concentrated protein and indispensable amino acids, although their nutritional value depends on raw-material composition and processing conditions [1-4].

Edible organs and other slaughter by-products may be valuable pet food ingredients rather than low-value waste streams. Their composition differs markedly among tissues: liver is generally nutrient dense and rich in several trace elements, whereas lung is typically leaner and contains a relatively high proportion of connective tissue. Consequently, organ type, ash content, connective-tissue content, and thermal history can influence protein solubility, amino acid availability, and digestibility [3-6]. Utilization of locally available by-products may also improve resource efficiency, but environmental benefits should not be assumed without a defined allocation method and life-cycle assessment [7,8].

Drying lowers water activity, facilitates grinding and storage, and can concentrate nutrients on an as-is basis. Nevertheless, an apparent increase in protein, fat, or minerals after drying primarily reflects removal of water rather than creation of nutrients. Heat intensity must also be controlled because excessive processing can reduce reactive lysine and promote Maillard reaction products, with potential consequences for protein quality [9-11]. Therefore, the nutritional value of a dried ingredient cannot be inferred from crude protein concentration alone.

Palatability is commonly assessed with acceptance tests or two-bowl preference tests. First choice and relative intake provide different information, and study design should account for bowl position, repeated observations, individual dog effects, and the paired data structure [12]. Recent studies demonstrate that animal-protein source and by-product inclusion can alter preference and nutrient utilization, but results vary with formulation and processing [1,2,13-15].

Horse meat production is culturally and economically important in Mongolia, yet scientific data on dried horse liver and lung in dog foods are limited. The objective of this study was therefore to characterize the proximate and selected mineral composition

of hot-air-dried horse liver and lung, develop prototype dry dog foods, assess microbiological quality in the analyzed batches, and evaluate feed acceptance and two-bowl preference in adult dogs. The study was designed as a preliminary product-development investigation rather than a demonstration of complete and balanced nutritional adequacy.

Materials and Methods

Raw materials and preparation

Horse liver and lung were obtained for product development and handled with reference to the general requirements described in Mongolian standard MNS 1023:2007 [16]; compliance with all provisions of that standard was not independently verified. Visible connective tissue and contaminants were removed, and the organs were cut into slices approximately 5 mm thick. The sliced liver and lung samples were dried in a hot-air drying oven at either 50°C or 70°C for 24 h, with 5 kg of each organ loaded per batch. Drying was continued until constant weight was achieved. For each organ, each temperature treatment was conducted using three independently prepared batches (n = 3 per organ-temperature condition). After drying, the materials were ground through an approximately 1 mm screen and stored in airtight packaging until formulation.

Product formulation and selection

Three prototype formulations containing 80%, 85%, or 90% dried horse liver or lung were prepared. Corn and peas flour were included at 2.5% each in all formulations, while bone oil was added at 15%, 10%, or 5%, respectively, resulting in a total formulation of 100% (Table 1). Ingredients were weighed according to the listed proportions and mixed to obtain homogeneous prototype mixtures. The available records did not specify the mixing equipment, mixing duration, or mixing speed. Prototype III, containing 90% dried horse liver or lung, 2.5% corn flour, 2.5% peas flour, and 5% bone oil, was selected for subsequent evaluation because it could be formed and handled satisfactorily during preliminary product development without visible structural failure; no formal sensory evaluation or objective texture scoring was conducted. The available records did not reliably identify or describe any subsequent forming, extrusion, pelleting, or molding step, nor did they document processing temperature, residence time, final drying conditions, cooling, final moisture adjustment, packaging material, or storage temperature and duration. These details cannot be reconstructed and are acknowledged as limitations affecting

full process reproducibility. The products are therefore treated as experimental prototype foods rather than fully reproducible commercial-type dry dog foods.

Formulation	Horse liver	Horse lung	Corn flour	Peas flour	Bone Oil	Total
Liver sample 1	80	-	2.5	2.5	15	100
Liver sample 2	85	-	2.5	2.5	10	100
Liver sample 3	90	-	2.5	2.5	5	100
Lung sample 1	-	80	2.5	2.5	15	100
Lung sample 2	-	85	2.5	2.5	10	100
Lung sample 3	-	90	2.5	2.5	5	100

Table 1: Ingredient composition of experimental dog-food formulations containing dried horse liver or lung (% as formulated).

Chemical and microbiological analyses

Moisture, crude protein, fat, and ash were determined according to MNS3746-84, MNS3745-84, MNS3748-84, and MNSISO 936:2003, respectively, and reported on an as-is basis. Iron and copper were quantified by atomic absorption spectroscopy (AAS) following microwave-assisted acid digestion and expressed as mg/kg product on an as-is basis. The archived record did not retain the AAS manufacturer/model, analytical wavelengths, calibration range and standards, blank and certified-reference-material results, spike/recovery data, dilution factors, or limits of detection and quantification. These details cannot be reconstructed and should be verified against the original laboratory report before publication. Carbohydrate and energy values were taken from laboratory source records; the calculation equation and analytical basis used for energy were unavailable, so these values are identified as laboratory-reported calculated values and were not independently recalculated or treated as validated metabolizable-energy estimates. Total aerobic bacterial counts were reported as determined using a serial-dilution plate-count procedure. *Escherichia coli*, molds/fungi, and *Salmonella* were assessed by the testing laboratory. The source records did not provide sample mass, culture media, enrichment procedures, incubation conditions, confirmation methods, or organism-specific detection limits. Results reported as “not detected” are therefore interpreted only as outcomes reported for the tested samples and do not establish comprehensive product safety. Three independently prepared batches were reportedly produced for each organ-temperature condition, and technical replicate analyses were reported; however,

replicate-level analytical observations were not retained. Tables 2-4 consequently present reported source-record values without recalculated variability estimates or inferential comparisons.

Dogs, feeding assessment, and palatability test

All procedures involving dogs were reviewed and approved by the Institutional Animal Care and Use Ethics Committee of the Mongolian University of Life Sciences (Approval No. VSBMR-2026/11; approved 27 March 2026). The authors should verify against the signed approval documentation that the approved protocol explicitly covered both the 28-day feeding assessment and the five-day two-bowl preference assessment. All procedures were reported to have been conducted in accordance with the approved protocol, with attention to animal welfare and minimization of unnecessary stress or discomfort.

Ten clinically healthy adult dogs (five males and five females), 2-4 years of age, with a mean body weight of 17.8 ± 1.3 kg and a body condition score of 4-5 on a 9-point scale, participated in the feeding assessment. Dogs underwent veterinary examination, routine vaccination, and deworming before the study. Feed was offered twice daily, and fresh water was available ad libitum. The feeding assessment lasted 28 days, comprising 21 days of adaptation followed by 7 days of observation. Daily amounts of food offered and refused were recorded. The comparator was a commercially available dry dog food, but the archived study record did not identify its manufacturer, product name, ingredient list, guaranteed analysis, energy density, or nutritional-adequacy statement. These details could not be verified and are not inferred.

Dog-level summaries were available for both test and control foods, but the archived record did not establish whether all dogs received both diets in a randomized crossover, the treatment order, duration of each diet exposure, or any washout period. The individual dog was treated as the experimental unit (n = 10), and feeding outcomes are presented descriptively because the treatment sequence and complete repeated-measures dataset could not be reconstructed.

A two-bowl preference assessment was conducted using the same 10 adult dogs to compare the selected test food with the commercial control. Each dog was simultaneously offered 200 g of the test food and 200 g of the control food in separate bowls for 30 min. These amounts were used for the short-term preference assessment and were not intended to represent the dogs’ total daily ration. The assessment was reported as having been conducted once daily for 5 consecutive days, giving a nominal total of 50 dog-day observations. Bowl positions were alternated between the left and right sides on successive test days to minimize positional bias. First choice was defined in the source record as the food first approached and consumed by the dog. Because the observations were repeated within the same dogs, the 50 observations were not treated as 50 independent animals.

First-choice percentage was calculated as (number of first choices for the test food / total valid first-choice observations) × 100. Test- and control-food consumption were summarized descriptively. The intake ratio was calculated from reported group mean intakes as test-food intake / control-food intake, and the corresponding preference index was calculated as [test-food intake / (test-food intake + control-food intake)] × 100. These indices are descriptive summaries of group mean intakes, not inferential statistics. Because the raw dog-level repeated observations were unavailable for an appropriate paired or repeated-measures model, no statistical significance is claimed for the apparent preference. The dog, rather than each repeated observation, remains the experimental unit (n = 10).

Statistical analysis

Dog feeding data are presented as mean ± standard deviation (SD) based on the available dog-level summaries. The dog was considered the experimental unit (n = 10). The archived record did not contain the complete individual-dog repeated-measures dataset, verifiable treatment sequence, or sufficient details of any crossover and washout periods; therefore, the calculation of the

reported group summaries could not be independently reproduced and inferential testing was not performed. The 50 nominal dog-day observations in the two-bowl assessment represent repeated observations from 10 dogs, not 50 independent animals. Tables 2-4 present source-record analytical values because replicate-level measurements were unavailable for independent recalculation of SD or statistical comparisons between drying temperatures.

Results

Proximate composition of fresh and dried horse liver and lung

Hot-air-dried horse liver and lung had low moisture contents and relatively high concentrations of crude protein, fat, and ash on an as-is basis (Table 2). For descriptive context, published fresh-organ reference values from Enkh-tuya.B [17] are shown alongside the experimental dried-material values. Moisture in dried liver was 8.2% at 50°C and 7.5% at 70°C, while dried lung contained 8.1% and 7.9% moisture at the corresponding temperatures.

Component	Fresh liver	Fresh lung	Liver, 50°C	Liver, 70°C	Lung, 50°C	Lung, 70°C
Moisture	71.2	78.2	8.2	7.5	8.1	7.9
Fat	3.9	1.8	15.6	14.7	15.8	13.94
Crude protein	22.09	17.9	31.62	31.3	31.26	31.68
Ash	1.6	1.4	4.38	4.49	5.79	5.88

Table 2: Proximate composition of fresh-organ reference materials and hot-air-dried horse liver and lung (% as-is basis; reported source-record values).

Note: Values are reported on an as-is basis and are source-record values. Fresh-organ reference values were obtained from Enkh-tuya. B [17] and are presented for descriptive comparison with the experimentally dried materials. Replicate-level analytical values were unavailable, so variability estimates and statistical comparisons could not be calculated.

Crude protein concentrations in dried liver were 31.62% and 31.30% at 50°C and 70°C, respectively, while dried lung contained 31.26% and 31.68%. Crude fat concentrations were 15.60% and 14.70% in dried liver and 15.80% and 13.94% in dried lung. Ash concentrations were 4.38-4.49% in dried liver and 5.79-5.88% in dried lung. Published fresh-organ values are included only as descriptive comparators and should not be interpreted as paired pre-drying measurements of the experimental batches.

Values at 50°C and 70°C were numerically similar for several proximate measures. Because replicate-level analytical data were unavailable for independent statistical testing, no inference is made regarding a drying-temperature effect.

Iron and copper concentrations

Iron and copper concentrations of the dried horse liver and lung are shown in Table 3 together with fresh-tissue comparator values from the source record. Dried liver contained 506 and 502 mg/kg iron at 50°C and 70°C, respectively, whereas dried lung contained 556 and 473 mg/kg. The fresh-tissue values are presented for descriptive context and are not treated as paired baseline measurements of the experimental dried batches.

Mineral	Fresh liver	Fresh lung	Liver, 50°C	Liver, 70°C	Lung, 50°C	Lung, 70°C
Iron (Fe), mg/kg	213.2	112.3	506	502	556	473
Copper (Cu), mg/kg	8.1	3.15	10.9	10.9	6.5	7.5

Table 3: Iron and copper concentrations of fresh-tissue reference materials and hot-air-dried horse liver and lung (mg/kg, as-is basis; reported source-record values)

Note: Values are expressed as mg/kg product on an as-is basis and are reported source-record values. Fresh-tissue values are presented for descriptive comparison; the dried materials were the experimental samples evaluated in this study. Replicate-level analytical values were unavailable, so variability estimates and statistical comparisons could not be calculated.

Copper concentrations in dried liver were 10.9 mg/kg at both drying temperatures, whereas dried lung contained 6.5 and 7.5 mg/kg at 50°C and 70°C, respectively. Because the values were reported on an as-is basis and paired fresh-to-dried mass-balance data were not available, the results should not be interpreted as evidence of mineral retention or loss during processing.

Nutritional and microbiological characteristics of the selected experimental formulations

Prototype III, formulated with 90% dried horse liver or lung, 2.5% corn, 2.5% peas, and 5% oil, was selected for subsequent

evaluation. The liver- and lung-based formulations contained 7.10% and 7.50% moisture, respectively, below the maximum value of 8.0% listed for moisture in the cited version of MNS 5688:2006 [18] (Table 4). The available records do not identify the oil type or the exact physical form of the corn and peas. This comparison is restricted to the reported parameters and should not be interpreted as confirmation of overall standard compliance or complete nutritional adequacy.

Parameter	MNS 5688:2006 [18]	Liver-based product	Lung-based product
Moisture, %	≤8.0	7.10	7.50
Crude protein, %	≥30.0	32.01	31.60
Crude fat, %	≥2.5	15.00	14.20
Reported carbohydrate, %	≥3.5	3.60	3.80
Ash, %	5.0-10.0	6.75	6.72
Reported energy, kcal/100 g	≥180	287.14	279.60
Total bacterial count, CFU/g	≤5.0 × 10 ²	3.0 × 10 ²	2.0 × 10 ²
<i>Escherichia coli</i>	Not detected	Not detected	Not detected
Molds/fungi	Not detected	Not detected	Not detected
<i>Salmonella</i>	Not detected	Not detected	Not detected

Table 4: Reported nutritional composition and microbiological findings for selected experimental dog-food formulations (as-is basis where applicable).

Note: Values are reported source-record analytical indices for the selected prototype products; replicate-level values were unavailable for recalculation of SD. Reported carbohydrate and energy values are presented as documented by the testing laboratory; the energy equation was not available. The listed compositional indices should not be summed to infer a complete 100% mass balance. “Not detected” indicates the laboratory report outcome; assay-specific detection limits were unavailable. Comparisons with MNS 5688:2006 are limited to the listed parameters and are not evidence of overall compliance.

Crude protein concentrations were 32.01% in the liver-based product and 31.60% in the lung-based product, while crude fat concentrations were 15.00% and 14.20%, respectively. Reported carbohydrate values were 3.60% and 3.80%, and ash contents were 6.75% and 6.72%, respectively. The laboratory source record reported energy values of 287.14 kcal/100 g for the liver-based product and 279.60 kcal/100 g for the lung-based product; because the original calculation equation was unavailable, these values were not independently recalculated or labeled as validated metabolizable energy estimates. For the individual parameters evaluated, the reported values were within the corresponding limits listed in MNS 5688:2006 [18]. The measured indices do not constitute a complete mass-balance analysis, and the unmeasured fraction of the product composition was not quantified.

Microbiological examination showed total bacterial counts of 3.0×10^2 CFU/g in the liver-based product and 2.0×10^2 CFU/g in the lung-based product. Both values were below the reported maximum limit of 5.0×10^2 CFU/g. *Escherichia coli*, molds/fungi, and *Salmonella* were reported as not detected in the analyzed samples. Because assay-specific detection limits and full culture conditions were not available in the source record, these findings support acceptable microbiological quality only for the tested batches under the laboratory conditions used; they do not establish shelf-life stability or comprehensive microbiological safety.

Feeding assessment

During the feeding assessment, mean daily intake was 186.5 ± 18.4 g/day for the commercial control food and 192.8 ± 17.6 g/day for the experimental test food (Table 5).

Parameter	Control food	Test food
Daily intake (g/day)	186.5 ± 18.4	192.8 ± 17.6
Body-weight-normalized intake (g/kg BW/day)	10.5 ± 0.9	10.8 ± 0.9
Time to finish eating (min)	8.4 ± 1.5	7.9 ± 1.3
Food residue (%)	3.4 ± 1.2	2.6 ± 1.0

Table 5: Descriptive feeding-assessment outcomes in dogs offered control and experimental formulations (n = 10 dogs)

Note: Values are mean $\pm$ SD based on the available dog-level summaries (10 dogs; dog is the experimental unit). The archived record did not permit independent reconstruction of the treatment sequence or repeated-measures dataset; results are descriptive.

Body-weight-normalized intake averaged 10.5 ± 0.9 g/kg BW/day for the control food and 10.8 ± 0.9 g/kg BW/day for the test food. The mean time required to finish eating was 8.4 ± 1.5 min for the control and 7.9 ± 1.3 min for the test food. Food residue was $3.4 \pm 1.2\%$ and $2.6 \pm 1.0\%$, respectively.

The descriptive feeding results indicate broadly comparable short-term voluntary intake and feeding behavior between the experimental and commercial comparator foods under the conditions recorded. Because the comparator’s identity and nutritional composition could not be verified and the treatment sequence could not be reconstructed, this comparison should not be interpreted as evidence of nutritional equivalence or superiority.

Two-bowl preference assessment

The two-bowl preference assessment showed a greater descriptive preference for the experimental horse-organ-based food (Table 6). The test food accounted for 60.0% of first-choice observations, compared with 40.0% for the commercial control.

Parameter	Result
First-choice observations for the test food (%)	60.0
First-choice observations for the control food (%)	40.0
Test food consumption (g)	86.4 ± 15.2
Control food consumption (g)	31.3 ± 17.8
Preference ratio (derived from mean intakes)	2.76
Preference index (% , derived from mean intakes)	73.4

Table 6: Descriptive two-bowl preference results in 10 dogs across 5 days (50 nominal repeated dog-day observations).

Note: The same 10 dogs were assessed on 5 consecutive days, giving 50 nominal dog-day observations (repeated observations, not 50 independent animals). Preference ratio and preference index are descriptive metrics derived from reported group mean intakes and are not inferential statistics. The source record did not allow independent reconstruction of dog-level daily intakes or the precise summary basis for the reported consumption values.

Mean consumption during the preference assessment was 86.4 ± 15.2 g for the test food and 31.3 ± 17.8 g for the control food. Based on these group mean intakes, the descriptive test-to-control intake ratio was 2.76 and the corresponding preference index was 73.4%. These derived values summarize the relative mean intakes and are not inferential statistics.

Together, these descriptive findings indicate greater mean short-term consumption of the experimental food than of the commercial comparator under the specific conditions of the two-bowl assessment. The observed 60:40 distribution of first-choice observations and the intake ratio and preference index derived from group means are descriptive only. Repeated observations were obtained from the same 10 dogs, and no inferential test was conducted; thus, the findings do not establish a statistically significant preference. The term “palatability” is used narrowly to refer to short-term intake and preference under this test, not to comprehensive palatability or long-term acceptance.

Discussion

This preliminary study describes hot-air-dried horse liver and lung and source-record outcomes for experimental dog-food formulations. The fresh-organ values were reference values, not paired pre-drying measurements from the experimental batches. Higher as-is concentrations after drying are consistent with water removal and concentration of dry matter; they do not demonstrate nutrient retention, nutrient gain, or loss. A valid retention estimate would require matched fresh and dried samples, product yield, and a mass-balance calculation.

Crude protein concentration alone does not establish protein quality or digestibility. Animal by-product meals vary in connective tissue, ash, amino acid composition, and digestibility [3-6], and raw-material source and processing can affect amino acid availability [1-4]. Amino acid profiling, reactive lysine measurement, and a validated digestibility assay would be needed before these ingredients could be described as nutritionally superior.

Thermal processing can influence aroma and color through Maillard chemistry, while excessive heat exposure may reduce reactive lysine and increase Maillard reaction products [9-11]. Neither a nutritional benefit nor a processing-related penalty can be concluded from color change alone because lysine availability and Maillard reaction products were not measured.

The recorded feeding summaries indicate broadly similar short-term intake magnitudes between the experimental formulation and the commercial comparator, while the two-bowl results show greater descriptive mean intake of the test food. First choice, intake ratio, preference index, and absolute consumption are distinct

outcomes [12]. The ratio and index here were derived from group mean intakes, and the same 10 dogs were observed repeatedly; no inferential test was conducted. Incomplete treatment-sequence and washout records, together with the unverified identity and nutritional composition of the comparator, prevent conclusions about statistically significant preference or nutritional equivalence. The findings are limited to short-term acceptance under the recorded test conditions.

The microbiological results apply only to the batches analyzed. The source records lacked assay-specific detection limits, sample mass for pathogen testing, culture media, enrichment and incubation conditions, confirmation methods, and water-activity measurements. Packaging properties and microbiological changes during storage were not evaluated. The final post-mixing processing sequence—including forming method, temperature, residence time, final drying, cooling, packaging, and storage—was also not reconstructable. Consequently, the available results do not establish comprehensive microbiological safety or shelf-life stability.

A major unresolved issue is that the reported compositional indices do not provide a complete mass balance: the proximate values do not sum to 100%, and the unmeasured fraction is not characterized in the source record. The original laboratory worksheets and calculation basis must be checked to verify the protein, fat, carbohydrate, ash, moisture, and energy values; the current record does not allow the discrepancy to be corrected reliably without risking fabrication. The energy equation was unavailable, so the energy figures are retained only as laboratory-reported calculated values and are not validated metabolizable-energy estimates. Although individual reported parameters were compared with values cited for MNS 5688:2006 [18], this limited comparison does not establish overall standard compliance. Essential amino acids, calcium, phosphorus, sodium, selected vitamins, fatty-acid profile, digestibility, and energy availability were not adequately characterized; the formulations cannot be classified as complete and balanced diets.

The study did not measure apparent total tract digestibility, amino acid balance, vitamin concentrations, calcium-to-phosphorus ratio, or long-term clinical outcomes. It therefore does not support claims about joint or bone benefits, coat quality, digestive health,

or suitability across species. Dried Mongolian horse liver and lung may warrant further ingredient and formulation research, but assessment of their use in complete diets requires verified composition data, nutrient and digestibility analyses, documented processing, and controlled safety and storage studies.

Conclusions

Hot-air-dried Mongolian horse liver and lung may be useful ingredients for further development of experimental dog-food formulations. The analyzed batches had the reported compositional and microbiological results, and short-term feeding intake was similar in magnitude to that of the commercial comparator. The two-bowl assessment showed greater descriptive mean intake of the test formulation, but repeated observations from the same 10 dogs do not establish statistically significant preference. Interpretation is limited by unavailable replicate-level analytical data, incomplete raw-material and equipment records, missing AAS quality-control details, incomplete microbiological methods, uncertain comparator identity, and incomplete feeding-study records. Most importantly, the reported composition does not provide a complete mass balance and the source records are insufficient to correct that discrepancy independently; the energy calculation also could not be verified. Final-product processing and storage conditions were not fully documented. The results should therefore be considered preliminary, batch-specific observations and not evidence of superior protein quality, nutritional equivalence, complete nutritional adequacy, comprehensive safety, or commercial shelf-life.

Conflict of Interests

No potential conflict of interest relevant to this article was reported.

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