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A Comparative Chemical Evaluation of Immune modulation Nutritional Components in Commercial Broiler Finisher Feeds in Al-Bayda City, Libya

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Abstract:

Feed quality and the nutritional composition of finisher diets are essential determinants of broiler production efficiency and nutritional adequacy. This study aimed to evaluate the chemical composition and selected immunonutritional components of commercial broiler finisher feeds obtained from Al-Bayda and surrounding agricultural areas in the Green Mountain region of Libya. The results were compared with the Libyan National Standard (LNCSM 58-1/2007), the National Research Council (NRC, 1994) recommendations, and breed-specific nutritional guidelines for Ross 308 and Cobb 500 broilers.

Feed samples were collected from six broiler farms and three commercial feed mills (A, B, and C), including individual and composite samples. Laboratory analyses were conducted to determine proximate composition, selected immunonutritional micronutrients (selenium, zinc, and vitamins A and E), and key immunity-associated amino acids.

Across the four final samples, crude protein ranged from 20.258% to 21.117%, crude fiber from 1.790% to 2.054%, moisture from 9.012% to 9.750%, ash from 4.172% to 5.461%, and ether extract from 3.173% to 3.547%. Reported metabolizable energy ranged from 2,950 to 3,250 kcal/kg. Zinc ranged from 69 to 134 mg/kg and selenium from 0.285 to 0.464 mg/kg; all four sample values exceeded the LNCSM/NRC reference concentrations reproduced in the manuscript. Vitamin A ranged from 1,667 to 3,818 IU/kg, while vitamin E ranged from 13 to 18 mg/kg. Vitamin A values were above the listed LNCSM/NRC reference but below the Ross 308 and Cobb 500 values shown in the comparison table. Vitamin E cannot be directly compared with the NRC and breeder-guide values reported in IU/kg because the vitamin E chemical form and activity conversion are not specified. The measured amino acids included lysine (1.18–1.21%), methionine (0.46–0.57%), arginine (1.12–1.25%), and threonine (0.75–0.80%); their concentrations exceeded the corresponding LNCSM/NRC values reproduced in the manuscript. These

are descriptive comparisons of the analysed samples, not evidence of immune effects or nutritional adequacy in live birds.
The analysed samples met or exceeded several listed LNCSM/NRC reference concentrations, while reported metabolizable energy was below 3,200 kcal/kg in mill B and the mill C mean. Differences from breeder-guide values require careful interpretation because some reference units or nutrient bases are not directly comparable with the laboratory results. As the study did not assess live birds, immune function, or production performance, further work using verified laboratory records and controlled feeding studies is needed before drawing conclusions about nutritional adequacy or biological effects.
Keywords: broiler finisher feed; chemical composition; immunonutrition; preliminary survey; Al-Bayda; Libya

1. Introduction

The poultry industry continually seeks to improve growth efficiency while maintaining animal health and welfare. Feed quality is central to this goal because nutrition contributes substantially to production costs and supplies substrates needed for growth, tissue maintenance, and normal physiological function. Nutritional management is therefore relevant to both sustainable production and the biological capacity of broilers to respond to challenges, although feed composition alone does not establish an immune outcome. [1–3]

Broiler feeding programs are divided into phases to align nutrient supply with age-related physiological and metabolic requirements and to reduce feed wastage. Feed intake rises with age, while the finisher phase is associated with high feed consumption, muscle accretion, and final body-weight gain. This period may also coincide with environmental and management stressors, including high stocking density. Consequently, finisher diets are important to production, but their nutritional effects should be evaluated using direct performance or health measures when such conclusions are intended. [4–12]

Immunonutrition describes the ways in which nutrients may influence immune-cell development and activity, antibody synthesis, inflammatory regulation, and barrier function. Protein and amino acids, energy, fatty acids, minerals, and vitamins all have physiological roles that can be relevant to these processes. However, the presence or concentration of such nutrients in a feed is not itself a measurement of immune status, vaccine response, disease resistance, or immune-cell function. [13–17]

Dietary energy supports maintenance, growth, and the metabolic costs of physiological responses. Protein supplies amino acids for tissue accretion and the synthesis of functional proteins, including some involved in host defence. Essential amino acids such as lysine, methionine, arginine, threonine, valine, leucine, and isoleucine are therefore relevant to both production and immune biology. At the same time, crude protein alone does not describe amino-acid balance, digestibility, or bioavailability. [18–24]

Dietary lipid contributes energy, essential fatty acids, membrane components, and facilitates absorption of fat-soluble vitamins. Dietary fiber may affect digesta characteristics and gut microbial ecology, although its effects depend on fiber type and amount. Ash is a broad measure of inorganic residue rather than a measure of individual mineral adequacy; moisture is relevant to feed storage and quality. Vitamins A and E and trace elements such as zinc and selenium have recognized physiological and antioxidant roles. These functions provide a rationale for measuring the nutrients, but they do not justify inferring immune effects in the absence of animal-level measurements. [25–36]

Zinc participates in numerous enzyme systems and immune-related processes, while selenium contributes to selenoproteins involved in antioxidant defence. Both nutrients are required in appropriate amounts; concentrations above a stated minimum should not automatically be interpreted as beneficial or safe without considering chemical form, total intake, and applicable upper limits. [23, 37–40]

Because commercial farms in the study area use rapidly growing broiler strains, feed values were compared with published Ross 308 and Cobb 500 specifications, as well as the Libyan national standard and NRC (1994). The present work was designed as a preliminary chemical survey of selected commercial finisher feeds from the Al-Bayda area. It assessed proximate composition, reported ME, zinc, selenium, vitamins A and E, and selected amino acids. It did not include live birds, performance measurements, or immunological assays. [41–44]

2. Materials and methods

2.1. Study design and sampling

This descriptive, laboratory-based survey evaluated commercial broiler finisher feed. No live animals were handled, sampled, or experimentally treated. Samples were collected from six commercial broiler farms in the Al-Bayda area of eastern Libya. The feed source was coded before laboratory analysis. Two farms provided individual samples from mills A and B; the other four farms received feed from mill C and were paired to form two composite samples. Thus, the final analytical set comprised four samples from three mills, not six independent final analytical samples.

At each farm, feed was taken from several locations within the storage unit to obtain approximately 1 kg. Each individual farm sample was reduced to 500 g using quartering: the feed was spread on a clean surface, divided into four portions, and two opposite portions were retained. For mill C, equal 500-g portions from farms 3 and 4 were combined to form composite sample C1; equal portions from farms 5 and 6 were combined to form composite sample C2. Each 1-kg composite was then reduced to 500 g by the same quartering procedure. Samples were placed in labelled, airtight plastic bags and transported to the external laboratory under suitable storage conditions. Sample codes and farm/mill information were recorded in a coded field log.

Table 1. Distribution of final finisher-feed samples by collection area, supplying mill, and sample type.

Final sample code	Collection area(s)	Feed mill	Sample type
S1	Omar Al-Mukhtar	A	Individual sample (farm 1)
S2	Shahat	B	Individual sample (farm 2)
S3 (C1)	Al-Haniya + Al-Hamama	C	Composite of farms 3 and 4
S4 (C2)	Al-Wasita + Qasr Al-Muqaddam	C	Composite of farms 5 and 6

Note. C1 and C2 are two composite samples supplied by the same mill (C); they are not separate feed companies. The four final samples represent six farms.

2.2. Chemical analysis of feed samples

All samples were analysed by an external laboratory using methods reported as consistent with AOAC International and ISO procedures. The laboratory-reported values were used as the analytical observations. The exact analytical report, detection limits, quality-control results, and chemical forms of measured micronutrients were not provided with the manuscript.

2.2.1. Proximate analysis

Crude protein was determined by the Kjeldahl method (AOAC 984.13 and ISO 5983-1:2005). Ether extract (crude fat) was determined by Soxhlet extraction (ISO 6492:1999). Crude fiber was determined using the Weende procedure (AOAC 978.10 and ISO 6865:2000). Moisture was determined by oven drying (AOAC method as reported by the laboratory; ISO 6496:1999), and crude ash by dry ashing (ISO 5984). The specific AOAC moisture-method suffix and the analytical basis (as-fed or dry-matter basis) should be confirmed from the laboratory report. [45–50]

2.2.2. Metabolizable energy

The ME values were reported as estimates generated using BESTMIX® feed-formulation software from feed-composition information. The supplied material does not identify the software version, module, nutrient database, input basis, or the exact prediction equation used. These details must be confirmed from the laboratory/software output before submission; no equation has been inferred or substituted here because doing so could produce values inconsistent with the reported ME data.

2.2.3. Mineral analysis

Zinc was determined by atomic absorption spectrometry (AAS), using AOAC Official Method 999.11 and ISO 6869:2000 as cited in the source material. Selenium was reported as determined by hydride-generation AAS using AOAC Official Method 996.17. Concentrations are presented uniformly in mg/kg. Zinc values reported in ppm were retained numerically because 1 ppm = 1 mg/kg; selenium values reported in ppb were converted using 1 ppb = 0.001 mg/kg. The edition/year for the cited AOAC selenium method should be verified. [51–53]

2.2.4. Vitamin analysis

Vitamin A was analysed by HPLC according to ISO 14565:2000 and is reported in IU/kg. Values originally reported in µg/100 g were converted using IU/kg = (µg/100 g × 10) ÷ 0.3, assuming retinol activity of 0.3 µg per IU. Vitamin E was analysed by HPLC according to ISO 6867:2000 and is reported in mg/kg; values in g/kg were multiplied by 1,000. Direct conversion of vitamin E mass concentration to IU/kg was not made because the chemical form and activity factor were not specified. [54–55]

2.2.5. Amino-acid analysis

Threonine, methionine, arginine, lysine, valine, isoleucine, leucine, proline, histidine, and phenylalanine were determined by HPLC as cited under ISO 13903:2005. Results are expressed as percentages. The manuscript treats the laboratory values as total amino-acid concentrations; no digestibility coefficients were measured or applied. [56]

2.3. Comparison with standards

Results were compared descriptively with the Libyan National Center for Standardization and Metrology standard for broiler feeds (LNCSM 58-1/2007), NRC (1994), Ross 308 nutrition specifications, and Cobb 500 performance and nutrition specifications. Values were compared only when units and analytical bases were sufficiently aligned. In particular, the 1% lipid-related values in some reference columns refer

to linoleic acid, not total ether extract; breeder-manual amino-acid values are digestible whereas the laboratory results and national/NRC entries are treated as total amino acids; and vitamin E values reported in IU/kg are not directly comparable with mg/kg without the chemical form and conversion factor. [41–44]

2.4. Statistical analysis

Because the final sample set was small and unbalanced, descriptive statistics were used and no inferential tests were performed. Mills A and B each had one final sample; therefore, no within-mill standard deviation can be estimated for them. Mill C had two composite samples, and its mean and sample standard deviation (SD; denominator n−1) were calculated from those two composite observations. Company C summaries in this revised manuscript were recalculated from the sample-level values in Tables 2–5. The percentage deviation was calculated as [(observed value − reference value) ÷ reference value] × 100. For maximum limits, a negative deviation means that the observed value is below the maximum; for a range, ether extract was compared with the lower bound only and separately checked against the upper bound. Calculations were performed using Microsoft Excel 2016.

3. Results

The final analytical set included four samples: S1 and S2 were single samples from mills A and B, and S3 and S4 were separate composite samples from mill C. Company C values below are mean ± sample SD for n = 2 composite samples. Values for companies A and B are single observations and should not be interpreted as estimates of between-lot or between-company variability.

Table 2. Proximate composition and reported metabolizable energy in the final feed samples.

Parameter	Unit	S1 (A)	S2 (B)	S3 (C1)	S4 (C2)	Mill C mean ± SD
Crude protein (CP)	%	20.945	20.258	20.602	21.117	20.860 ± 0.364
Ether extract (EE)	%	3.547	3.528	3.173	3.354	3.264 ± 0.128
Crude fiber (CF)	%	2.054	1.955	1.79	1.899	1.845 ± 0.077
Moisture	%	9.012	9.333	9.75	9.541	9.646 ± 0.148
Ash	%	4.18	4.172	5.135	5.461	5.298 ± 0.231
Metabolizable energy (ME)	kcal/kg	3250	3005	2950	2950	2950.000 ± 0.000

Note. The individual sample values are retained as supplied. Company C summaries are recalculated as mean ± sample SD from S3 and S4. ME is reported from the source records; its equation/model was not supplied.

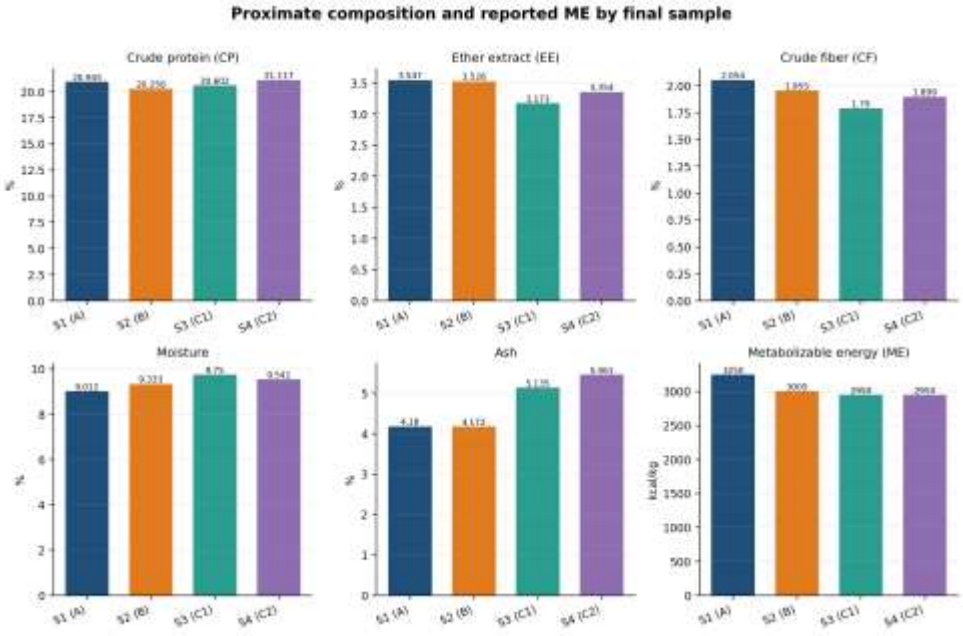

Figure 1. Proximate composition and reported ME for each final sample. Proximate components are plotted in separate panels because their numerical ranges differ; ME is shown in kcal/kg. C1 and C2 are two composite samples from mill C.

Table 3. Zinc and selenium concentrations in the final feed samples.

Parameter	Unit	S1 (A)	S2 (B)	S3 (C1)	S4 (C2)	Mill C mean ± SD
Zinc	mg/kg	70	69	114	134	124.00 ± 14.14
Selenium	mg/kg	0.38	0.285	0.464	0.43	0.447 ± 0.024

Note. Selenium values originally reported in ppb were converted to mg/kg (1 ppb = 0.001 mg/kg). Company C summaries are recalculated from S3 and S4.

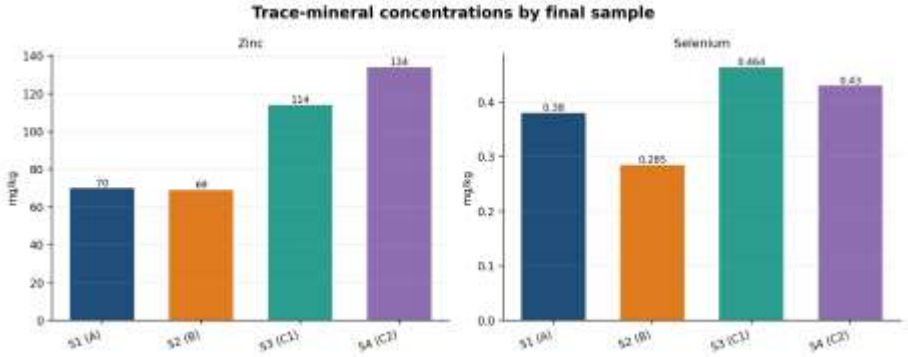

Figure 2. Zinc and selenium concentrations by final sample. Both minerals are presented in mg/kg.

Table 4. Vitamin concentrations in the final feed samples after unit harmonization.

Parameter	Unit	S1 (A)	S2 (B)	S3 (C1)	S4 (C2)	Mill C mean ± SD
Vitamin A	IU/kg	2,380	3,818	1,667	1,707	1,687 ± 29
Vitamin E	mg/kg	13	17	17	18	17.5 ± 0.7

Note. Vitamin A values were converted from µg/100 g to IU/kg using the stated retinol conversion. Vitamin E values were converted from g/kg to mg/kg. Company C summaries are recalculated from S3 and S4.

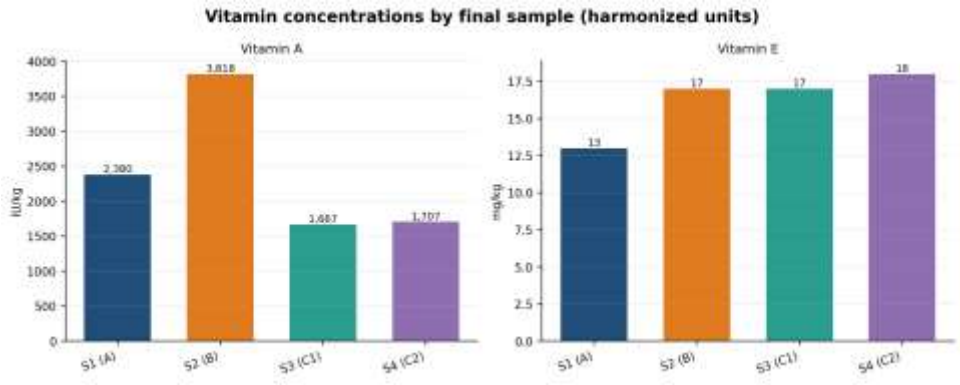

Figure 3. Vitamin A (IU/kg) and vitamin E (mg/kg) concentrations by final sample. Separate panels are used because units and scales differ.

Table 5. Total amino-acid concentrations in the final feed samples.

Amino acid	Unit	S1 (A)	S2 (B)	S3 (C1)	S4 (C2)	Mill C mean ± SD
Threonine	%	0.78	0.75	0.80	0.80	0.800 ± 0.000
Methionine	%	0.46	0.48	0.57	0.57	0.570 ± 0.000
Arginine	%	1.15	1.12	1.23	1.25	1.240 ± 0.014
Lysine	%	1.21	1.20	1.19	1.18	1.185 ± 0.007
Valine	%	0.89	0.85	0.90	0.92	0.910 ± 0.014
Isoleucine	%	0.80	0.77	0.82	0.83	0.825 ± 0.007
Leucine	%	1.69	1.63	1.79	1.77	1.780 ± 0.014
Proline	%	1.15	1.11	1.18	1.19	1.185 ± 0.007
Histidine	%	0.50	0.49	0.53	0.54	0.535 ± 0.007
Phenylalanine	%	0.98	1.00	1.03	1.05	1.040 ± 0.014

Note. Results are percentages as reported by the laboratory and are treated as total amino-acid concentrations. Company C mean ± sample SD values were recalculated from S3 and S4; no digestibility correction was applied

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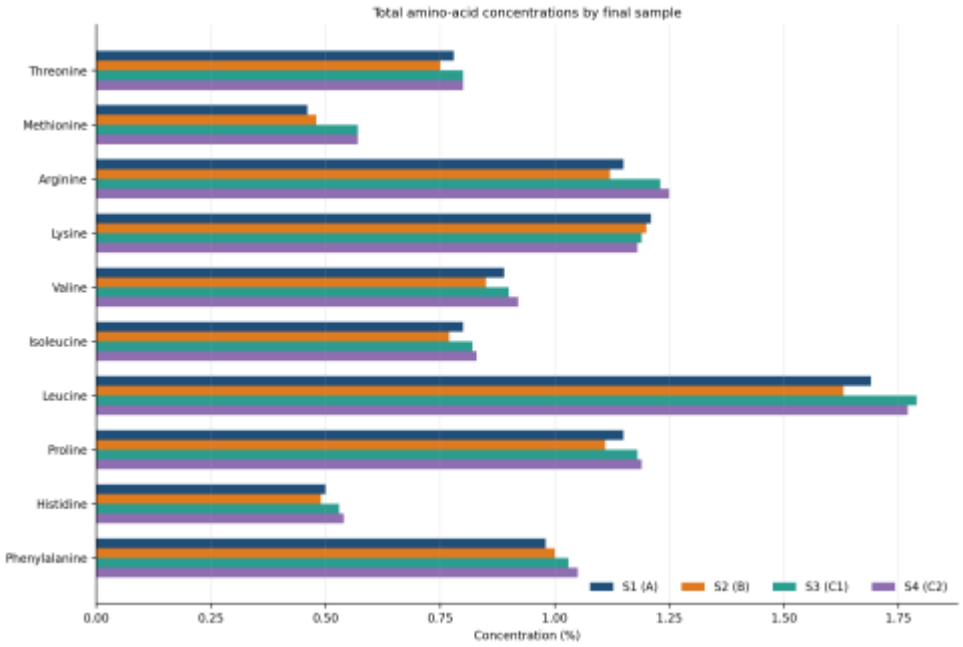

Figure 4. Total amino-acid concentrations (%) for S1, S2, C1, and C2. C1 and C2 are composite samples from the same mill.

3.1. Comparison with reference values

The comparisons below reproduce the reference values supplied with the study, with units made explicit where possible. "ND" denotes that no value was listed in the source comparison table. "NC" denotes that a direct quantitative comparison is not appropriate because the measured and reference quantities differ in unit, chemical form, or amino-acid basis.

Table 6. Proximate analysis compared with LNCSM, NRC, Ross 308, and Cobb 500 reference values.

Parameter	Unit	A	B	C mean ± SD	LNCSM	NRC (1994)	Ross 308	Cobb 500
CP	%	20.945	20.258	20.860 ± 0.364	18	18	19.5	17–18
EE	%	3.547	3.528	3.264 ± 0.128	2.5–9	1*	1*	1*
CF	%	2.054	1.955	1.845 ± 0.077	≤5	ND	ND	ND
Moisture	%	9.012	9.333	9.646 ± 0.148	≤12	ND	ND	ND
Ash	%	4.180	4.172	5.298 ± 0.231	≤7.5	ND	ND	ND
ME	kcal/kg	3,250	3,005	2,950 ± 0	3,200	3,200	3,100	3,150

Note. *The 1% reference is reported as linoleic acid, not total ether extract; no direct comparison with measured EE was made. ND = no value listed. Company C is the mean of two composite samples. The B values for CF and ME are harmonized to the raw analytical table (1.955% and 3,005 kcal/kg, respectively); see the author-check note.

Table 7. Zinc and selenium compared with reference values.

Parameter	Unit	A	B	C mean ± SD	LNCSM	NRC (1994)	Ross 308	Cobb 500
Zinc	mg/kg	70	69	124 ± 14.14	40	40	120	100
Selenium	mg/kg	0.380	0.285	0.447 ± 0.024	0.15	0.15	0.30	0.35

Note. All sample and reference selenium concentrations are expressed in mg/kg. Zinc ppm values are numerically equivalent to mg/kg. Company C summaries are the mean ± sample SD of two composite samples.

Table 8. Vitamin concentrations compared with reference values.

Parameter	Sample unit	A	B	C mean ± SD	LNCSM value	NRC value	Ross 308 value	Cobb 500 value
Vitamin A	IU/kg	2,380	3,818	1,687 ± 29	1,500	1,500	10,000	10,000
Vitamin E	mg/kg	13	17	17.5 ± 0.7	10†	10 IU/kg	55 IU/kg	50 IU/kg

Note. Vitamin A values and standards are in IU/kg. Vitamin E sample values are in mg/kg; the LNCSM value is shown as 10† because its unit should be verified against the original standard. NRC and breeder values are expressed in IU/kg and are not directly comparable with the measured mg/kg without the vitamin E chemical form/activity factor. †Conditional comparison only if the LNCSM value is confirmed to be mg/kg.

Table 9. Total amino-acid concentrations compared with the listed reference values.

Amino acid	Unit	A	B	C mean ± SD	LNCSM total	NRC total	Ross digestible	Cobb digestible
Threonine	%	0.78	0.75	0.800 ± 0.000	0.68	0.68	0.72	0.56
Methionine	%	0.46	0.48	0.570 ± 0.000	0.32	0.32	0.48	0.35
Arginine	%	1.15	1.12	1.240 ± 0.014	1.00	1.00	1.17	0.95
Lysine	%	1.21	1.20	1.185 ± 0.007	0.85	0.85	1.08	0.86
Valine	%	0.89	0.85	0.910 ± 0.014	0.70	0.70	0.84	0.67
Isoleucine	%	0.80	0.77	0.825 ± 0.007	0.62	0.62	0.75	0.57
Leucine	%	1.69	1.63	1.780 ± 0.014	0.93	0.93	1.19	0.95
Proline	%	1.15	1.11	1.185 ± 0.007	0.46	0.46	ND	ND
Histidine	%	0.50	0.49	0.535 ± 0.007	0.27	0.27	ND	ND
Phenylalanine	%	0.98	1.00	1.040 ± 0.014	0.56	0.56	ND	ND

Note. Laboratory and LNCSM/NRC values are treated as total amino acids, whereas Ross 308 and Cobb 500 values are digestible amino acids; direct quantitative comparison with breeder-manual values was therefore not performed. ND = no reference value listed; the "MD" entry in the supplied table was standardized to ND. Company C summaries were recalculated from sample-level data.

Table 10. Percentage deviation of each company-level value from the LNCSM reference.

Nutrient	LNCSM reference and basis	Company A	Company B	Company C mean
CP	18% (minimum)	+16.4%	+12.5%	+15.9%
EE	2.5–9% (range; deviation vs 2.5% lower bound)	+41.9%	+41.1%	+30.5%
CF	5% (maximum)	-58.9%	-60.9%	-63.1%
Moisture	12% (maximum)	-24.9%	-22.2%	-19.6%
Ash	7.5% (maximum)	-44.3%	-44.4%	-29.4%
ME	3,200 kcal/kg (reference)	+1.6%	-6.1%	-7.8%
Zinc	40 mg/kg (minimum)	+75.0%	+72.5%	+210.0%
Selenium	0.15 mg/kg (minimum)	+153.3%	+90.0%	+198.0%
Vitamin A	1,500 IU/kg (minimum)	+58.7%	+154.5%	+12.5%
Vitamin E	10 mg/kg† (conditional)	+30.0%	+70.0%	+75.0%
Threonine	0.68% (total)	+14.7%	+10.3%	+17.6%
Methionine	0.32% (total)	+43.8%	+50.0%	+78.1%
Arginine	1.00% (total)	+15.0%	+12.0%	+24.0%
Lysine	0.85% (total)	+42.4%	+41.2%	+39.4%
Valine	0.70% (total)	+27.1%	+21.4%	+30.0%
Isoleucine	0.62% (total)	+29.0%	+24.2%	+33.1%
Leucine	0.93% (total)	+81.7%	+75.3%	+91.4%
Proline	0.46% (total)	+150.0%	+141.3%	+157.6%
Histidine	0.27% (total)	+85.2%	+81.5%	+98.1%
Phenylalanine	0.56% (total)	+75.0%	+78.6%	+85.7%

Note. Deviation (%) = [(observed − reference) ÷ reference] × 100. For maximum limits (CF, moisture, ash), a negative value means the observed concentration is below the maximum. EE is calculated against the lower bound only; all measured EE values are within the full 2.5–9% range. Vitamin E values marked † are conditional on confirmation that the LNCSM value is mg/kg. Company C is the mean of two composites.

Table 11. Percentage deviation of each company-level value from the NRC (1994) reference, where a direct comparison is valid.

Nutrient	NRC reference and basis	Company A	Company B	Company C mean
CP	18% (minimum)	+16.4%	+12.5%	+15.9%
EE	1% linoleic acid; not total EE	N/C	N/C	N/C
CF	ND	N/C	N/C	N/C
Moisture	ND	N/C	N/C	N/C
Ash	ND	N/C	N/C	N/C
ME	3,200 kcal/kg (reference)	+1.6%	-6.1%	-7.8%
Zinc	40 mg/kg (minimum)	+75.0%	+72.5%	+210.0%
Selenium	0.15 mg/kg (minimum)	+153.3%	+90.0%	+198.0%
Vitamin A	1,500 IU/kg (minimum)	+58.7%	+154.5%	+12.5%
Vitamin E	10 IU/kg; not comparable to mg/kg	N/C	N/C	N/C
Threonine	0.68% (total)	+14.7%	+10.3%	+17.6%
Methionine	0.32% (total)	+43.8%	+50.0%	+78.1%
Arginine	1.00% (total)	+15.0%	+12.0%	+24.0%
Lysine	0.85% (total)	+42.4%	+41.2%	+39.4%
Valine	0.70% (total)	+27.1%	+21.4%	+30.0%
Isoleucine	0.62% (total)	+29.0%	+24.2%	+33.1%
Leucine	0.93% (total)	+81.7%	+75.3%	+91.4%
Proline	0.46% (total)	+150.0%	+141.3%	+157.6%
Histidine	0.27% (total)	+85.2%	+81.5%	+98.1%
Phenylalanine	0.56% (total)	+75.0%	+78.6%	+85.7%

Note. N/C = not comparable; ND = no reference value listed. The NRC 1% lipid-related value refers to linoleic acid rather than total ether extract. Vitamin E values are not compared because the sample results are mg/kg and the NRC value is IU/kg, with chemical form/activity factor unspecified. All reported amino-acid comparisons use the total-amino-acid values provided in the source table.

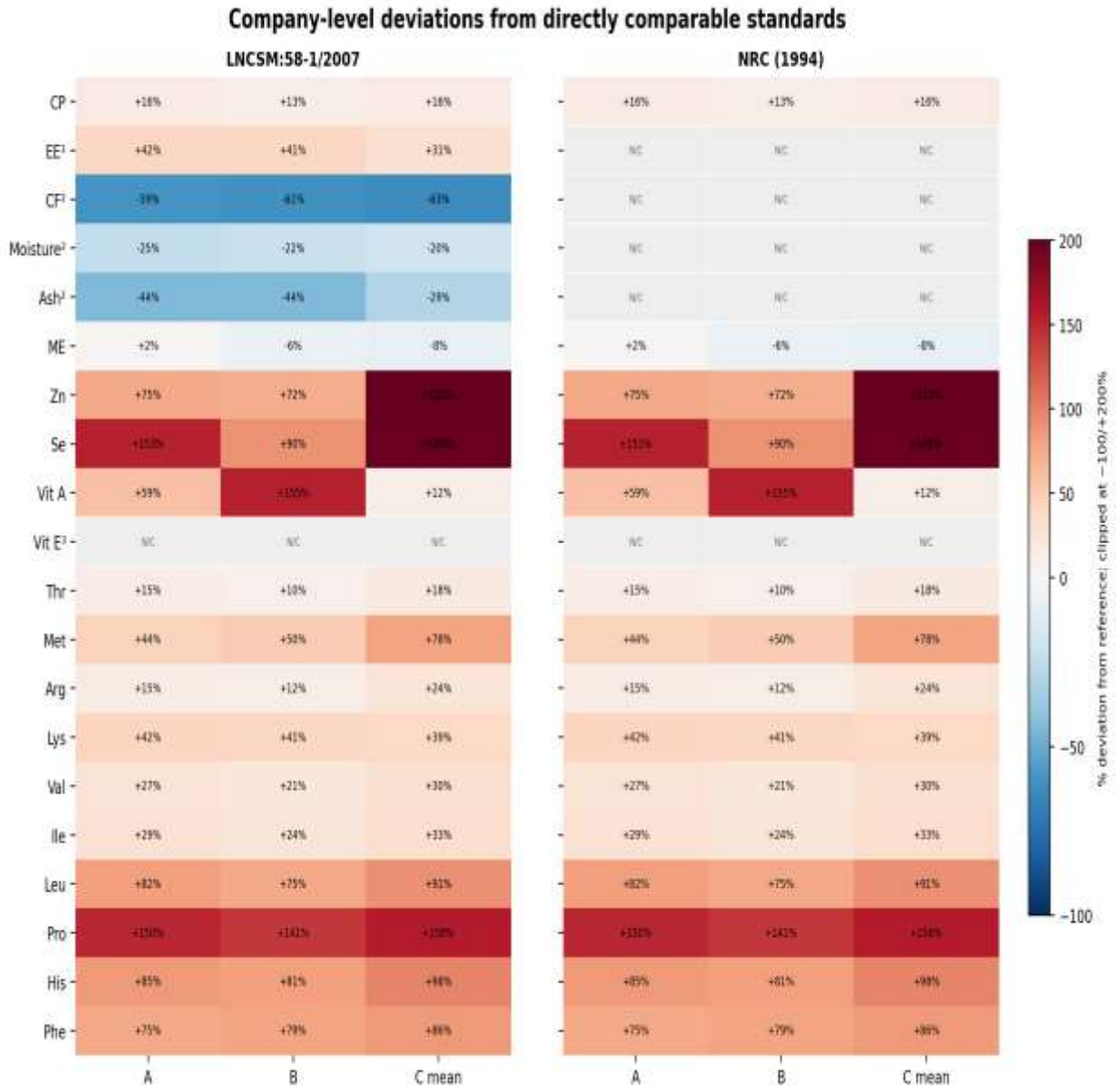

Figure 5. Heat map of company-level percentage deviations from LNCSM and NRC values. Gray N/C cells indicate absent or non-comparable reference values. Color encodes signed numerical deviation only; it does not uniformly indicate adequacy because maximum limits, minimum requirements, ranges, and reference values have different interpretations. EE is compared with the LNCSM lower bound only; vitamin E is excluded from direct comparison.

4. Discussion

This preliminary survey describes the chemical composition of four final feed samples from three mills in the Al-Bayda area. Several measured nutrients were above the minimum values listed in the supplied national/NRC comparison tables, while ME was below 3,200 kcal/kg in the mill B sample and mill C mean. These findings apply to the samples analysed and do not establish the composition of all feeds sold in Libya. Because no birds were studied, the results cannot demonstrate effects on growth, immune response, disease resistance, vaccine response, or oxidative status.

4.1. Crude protein and amino acids

Company-level crude protein values ranged from 20.26% (mill B) to 20.95% (mill A), with a mean of 20.86% for mill C. These values are above the 18% LNCSM/NRC comparison value and the cited finisher values in the Ross 308 and Cobb 500 manuals. Such differences should be interpreted in the context of each specification's age, formulation basis, and whether the value is a minimum or target. Higher crude protein does not necessarily improve performance or immunity; when protein supply is not matched to amino-acid requirements, it may increase nitrogen excretion and feed cost. Lower-protein formulations balanced with crystalline amino acids have been investigated as a means to reduce nitrogen output while maintaining performance, but this survey did not evaluate formulation efficiency or bird response. [23, 41–42, 57–61]

The measured total concentrations of threonine, methionine, arginine, lysine, valine, isoleucine, leucine, proline, histidine, and phenylalanine exceeded the corresponding LNCSM/NRC values reproduced in Table 9. This is a descriptive comparison only: amino-acid availability depends on digestibility, processing, and the complete diet. Ross 308 and Cobb 500 specifications list digestible amino acids, whereas the laboratory values and the national/NRC values in the supplied table are treated as total amino acids; a direct numerical comparison with the breeder specifications is therefore inappropriate. Amino acids have plausible and documented roles in mucosal proteins, antioxidant pathways, and immune-related protein synthesis, but feed concentrations alone do not establish that these pathways were altered in the birds consuming these feeds. [13, 21, 62–70]

4.2. Metabolizable energy

Reported ME values ranged from 2,950 to 3,250 kcal/kg. Mill A was above the 3,200-kcal/kg comparison value (3,250 kcal/kg), whereas mill B (3,005 kcal/kg) and the mill C mean (2,950 kcal/kg) were below it. These differences warrant confirmation against the original laboratory report and feed formulation records, particularly because the manuscript does not include the BESTMIX® version, the model/database, the input basis, or the equation used to generate ME. ME contributes to energy supply for production and physiological function, but no performance or immune-metabolic outcomes were measured here; consequently, suitability cannot be concluded from ME values alone. [18–20, 71]

4.3. Ether extract and crude fiber

Ether extract ranged from 3.173% to 3.547% across individual samples and was within the supplied LNCSM range of 2.5–9%. The 1% values shown for NRC and breed manuals refer to linoleic acid rather than total ether extract and were not used as direct comparators. Dietary lipids can contribute energy and essential fatty acids, but this survey did not measure fatty-acid profile, lipid quality, or digestibility. [44, 72–79]

Crude fiber ranged from 1.790% to 2.054% in individual samples, below the LNCSM maximum of 5%. Total crude fiber does not identify fiber source, solubility, fermentability, or particle characteristics.

Therefore, the values cannot by themselves indicate whether the feeds provide a functional fiber level for gut health. [28–29, 80]

4.4. Moisture and ash

Moisture ranged from 9.012% to 9.750%, below the LNCSM maximum of 12%. Ash ranged from 4.172% to 5.461%, below the supplied maximum of 7.5%. These measurements are useful for basic feed characterization, but moisture values alone do not establish microbiological safety, and total ash does not show the amounts or balance of individual minerals such as calcium, phosphorus, sodium, or potassium. Only zinc and selenium were measured among the trace minerals reported here. [30–33]

4.5. Zinc and selenium

Company-level zinc values were 69–124 mg/kg, and selenium values were 0.285–0.447 mg/kg. Each company-level value exceeded the LNCSM/NRC minimum listed in the comparison table (40 mg/kg zinc and 0.15 mg/kg selenium). Relative to the breeder-guide values, zinc in mills A and B was below the listed 100–120 mg/kg range, whereas the mill C mean was 124 mg/kg. Selenium in mill B (0.285 mg/kg) was below the listed Ross/Cobb values (0.30 and 0.35 mg/kg); the values for mills A and C were above those reference values. These are comparisons with reference concentrations, not evidence that the measured feeds were safer or more immunologically effective. Mineral source, total intake, antagonists, and upper safe limits were not assessed. [23, 37–40]

4.6. Vitamins A and E

Vitamin A values were 1,667–3,818 IU/kg among the individual samples (company C mean 1,687 IU/kg). Company-level values exceeded the 1,500-IU/kg LNCSM/NRC reference but were below the 10,000-IU/kg Ross 308 and Cobb 500 values listed in the source comparison table. This is a compositional comparison and does not establish vitamin A adequacy in the complete diet or an immune response. [23, 36]

Vitamin E values were 13–18 mg/kg among the individual samples (company C mean 17.5 mg/kg). The supplied table lists LNCSM as 10 without a confirmed unit and lists NRC and breeder values in IU/kg. Consequently, the comparison with the LNCSM value is conditional on verifying that its unit is mg/kg; comparisons with IU/kg values cannot be made directly without identifying the vitamin E chemical form and activity conversion. Claims that the measured vitamin E was above or below the NRC or breeder recommendations should therefore be avoided until the source units are verified. Selenium and vitamin E have complementary roles in antioxidant systems, but those functions were not measured in this study. [34–35, 37]

5. Study Limitations

This study has several limitations. First, the final analytical set comprised only four samples from six farms: mills A and B were each represented by one sample, while mill C was represented by two composites. The design was therefore unbalanced and cannot estimate within-mill or between-lot variability for mills A and B or support broad inference about commercial feeds in Libya. The two mill C composites provide only a limited descriptive estimate of spread.

Second, sampling was cross-sectional and limited to the Al-Bayda area. Feed composition may vary by production date, formulation, ingredient source, storage, and season. The supplied material did not include a complete laboratory report, quality-control data, detection limits, or a documented basis for all percentage values.

Third, no live birds, feeding trial, production outcomes, immune biomarkers, vaccine responses, disease challenge, oxidative-stress indicators, or feed intake were assessed. Accordingly, the study evaluates chemical composition only and cannot demonstrate immune modulation, immune protection, or production effects. The reported minerals and vitamins also do not establish bioavailability or total dietary exposure.

Fourth, some standards and measurements are not directly comparable. The amino-acid results are treated as total concentrations, whereas breeder specifications report digestible amino acids. Vitamin E is reported in mg/kg in the samples but partly in IU/kg in the comparison sources, and the LNCSM vitamin E unit requires confirmation. Finally, the ME equation, BESTMIX® version, and input assumptions were not supplied, and two values in the original comparison table differed from the raw analytical table. These methodological and transcription issues should be resolved against primary records before the results are used for regulatory or commercial decisions.

6. Conclusion

In this small preliminary survey, the analysed broiler finisher feeds showed crude protein, zinc, selenium, vitamin A, and measured total amino-acid concentrations above the LNCSM/NRC values reproduced in the manuscript; ether extract was within the supplied LNCSM range, and crude fiber, moisture, and ash were below the listed maximum limits. Reported ME was 3,250 kcal/kg in mill A, 3,005 kcal/kg in mill B, and 2,950 kcal/kg for mill C, so two of the three company-level values were below the 3,200-kcal/kg comparison value. Vitamin E comparisons require confirmation of reference units and chemical form, and breeder-guide amino-acid values are not directly comparable with total laboratory values. Because the study included no birds or immune measurements, it supports conclusions about selected feed samples only—not about immune response, performance, or the adequacy of all commercial feeds in Libya.

7. Recommendations

Conduct follow-up studies with a larger, balanced set of feed samples from more mills, regions, seasons, production lots, and broiler feeding phases.

Obtain and archive full laboratory certificates, including analytical basis, method versions, detection limits, quality-control results, and nutrient chemical forms.

Confirm the BESTMIX® version, nutrient database, assumptions, and exact ME prediction equation; reconcile reported ME and crude-fiber values with the original laboratory/software output.

Use controlled feeding studies to relate verified feed composition to bird performance and pre-specified immune or oxidative-status outcomes.

Develop an updated Libyan database of broiler-feed composition linked to strain, feeding phase, ingredient profile, and production outcomes, through cooperation among universities, laboratories, feed manufacturers, and farms.

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