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Availability and quality of raw materials used in intensive poultry farming in Burkina Faso: The case of the city of Ouagadougou

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ABSTRACT

Feed, especially quality feed, is one of the major challenges facing intensive peri-urban poultry farming in Burkina Faso. The aim of this study was to assess the availability and the quality of poultry feed in the city of Ouagadougou. Indeed, a survey was conducted at the main livestock markets in this city to inventory the raw materials (organic and mineral sources) that are marketed for poultry feeding. A total of 223 samples of organic raw materials and 22 mineral source samples were collected and analyzed by standard methods to determine their composition and qualities. The results generated indicate that, excluding rice bran, sesame seeds, and peanuts, most of feeds of organic basing inventoried and analyzed, contained acceptable crude cellulose (CC) levels, qualifying them as single concentrate feeds. Peanut, sesame and soybean seeds showed fairly good crude protein (CP) contents, ranging from 21.88 to 36.34%, with relatively high fat matter (FM) and CC contents of 17 to 37% and 13.7 to 24.08% respectively. As a result, the CC content of the expeller cake from unhusked cotton seeds exceeded the recommended value of 15%. Almost all the feeds of organic basing analyzed were richer in phosphorus than in calcium. Copper levels in cereal samples ranged from 3.53 to 10.3 ppm, and zinc levels from 4.53 to 23.5 ppm (mg/kg DM). Bran samples had copper and zinc contents ranging from 4.33 to 12.72 ppm and 20.66 to 74.94 ppm respectively. The husked-extracted cottonseed cake had higher copper and zinc contents than the unhusked expeller cottonseed cake. These results could serve as a referential for the animal feed industry by providing more detailed data on the qualities of the feed ingredients required for the manufacture of animal feed.

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INTRODUCTION

In Burkina Faso, the poultry flock is estimated at over 44 million head and the production segment of the sector involves nearly 1.6 million households (FAO, 2019). It is the main source of income for over 86% of rural households. Its products are used to supplement cereals in the human diet and help meet protein requirements (Addass *et al.*, 2012; Mweugang *et al.*, 2021; Zongo *et al.*, 2024). Three systems coexist in poultry farming in Burkina Faso: extensive, semi-intensive and intensive one (Pinde *et al.*, 2020; Guisso *et al.*, 2022; Ouedraogo *et al.*, 2024). With population growth accelerating in recent years, intensive poultry farming with improved breeds is becoming increasingly important, especially in peri-urban areas (FAO, 2019). The boom in this type of farming has created a high number of poultry feed factories in Burkina Faso. In order to create new vitality and effectively support the production of high-quality feed by these feed mills and meet market demand, it is necessary to provide data on the nutritional qualities of the primary feed materials used in manufacturing. Feed rations are formulated by feed specialists according to the nutritional requirements of each animal category and expected production (Brah *et al.*, 2016; Atchade *et al.*, 2019; Ky *et al.*, 2020). This requires perfect knowledge of the various primary feeds and their nutritional values. To date in Burkina Faso, animal feed formulators refer to European and American standard documents, some of which date back several decades. Typical reference documents on animal feed in Burkina Faso are practically inexistent, and the few data that are available are rarely updated and often incomplete for certain parameters. A more detailed determination of the bromatological values of livestock feeds in Burkina Faso should therefore be used to create local referential for the qualities of available raw materials, and as user guides for feed manufacturers and government technical staff in charge of national feed quality control and inspection. The purpose of this study was to contribute to a better characterization of the nutritional potential of primary feeds intended for poultry feeding in intensive peri-urban farms in Ouagadougou.

MATERIALS AND METHODS

Feed sampling methods for quality analysis

Surveys were conducted among traders at the three main livestock markets in the Ouagadougou's city (Tanghin, Tampouy, Gounghin). These surveys provided an inventory of the raw materials available (organic and mineral sources) and sold for poultry feed. After each interview with an actor in those markets, samples of the raw materials concerned were taken for laboratory's analysis in order to determine their nutritional qualities. The samples were collected using a measuring cup (ladle). Before each sampling, the operator put on gloves, and between successive samplings, the measuring cup was properly cleaned. The samples collected were immediately stored in a zip-lock bag and labeled according to pre-established codes based on the collection site. A properly prepared sampling form was used to record information on the targets and feed samples collected. A total of 223 samples of organic raw materials, 22 samples of mineral feed materials, were collected. All samples were sent to the laboratory for various analyses.

Laboratory analysis methodology

The parameters analysed in the laboratory were: dry matter (DM), total nitrogen matter or Crude protein (CP), fat matter (FM), crude cellulose (CC), mineral matter (MM) or crude ash, phosphorus (P), calcium (Ca), zinc (Zn), copper (Cu) and iron (Fe) for feed only.

The determination of dry matter (DM) and mineral matter (MM) was based on AOAC standard methods (AOAC, 1984).

Dry matter was determined after oven-drying 2.5 g of the sample for 12 hours at 105°C. After drying, the sample was weighed to determine DM.

For crude ash (total mineral matter), feed samples were weighed and placed in an electric muffle furnace at 550°C for 3 hours, and the products obtained were weighed and expressed as relative dry matter values for each sample.

Nitrogenous matter was determined using the method of (Kjeldahl, 1883) which involves mineralizing the samples with sulfuric acid (95%) at 480°C for 167 min in the mineralizer, distilling using a distillation apparatus and titrating the distillates.

Fats were dosed using the (Soxhlet, 1879) method, in accordance with ISO-659 (1998), using di-ethyl ether as the solvent (AOAC, 1984).

Calcium, zinc, copper and iron were determined by atomic absorption spectrophotometry (AAS), using the Perkin Elmer AAS 300 Equipment, according to Beer-Lambert's law. One (1) ml of extract is diluted with 10 ml of 1% lanthanum solution. The diluted solution is then run through the AAS 300 to determine the above-mentioned elements (Clément, 1971).

Phosphorus levels in the mineralization were determined using a manual colorimeter in the presence of potassium tartrate antimony and ammonium molybdate as indicator.

Determinations of DM, CP, CC and CA were carried out at the Laboratory of Research in Animal Production and Health (LaRePSA) of the Institute of the Environment and the Researches on Agriculture (INERA) of the National Center for Scientific and Technological Research (CNRST) of Burkina Faso.

Fats were determined at the laboratory for feed biotechnology (LBTA) of the Institute for Research in Applied Sciences and Technology (IRSAT) of the National Centre for Scientific and Technological Research (CNRST).

Mineral analyses were carried out at the Bureau National des Sols (BUNASOL) laboratory of the Burkina Faso Ministry of Agriculture, Animal and Fisheries Resources (MARAH) of Burkina Faso.

For the determination of feed energy, two (2) equations reported by (INRA, 1989) were used, one applying to simple feeds (raw material feeds) for the determination of gross energy (GE) and the other applying to compound feeds (feeds from poultry feed manufacturers) for the determination of metabolizable energy (ME). The equation of (Schiemann *et al.,* 1971) was used to determine the gross energy (GE) of feedstuffs:

$$GE = 57.2xCP + 95.0xFM + 47.9xCC + 41.7xNNE + \Delta t \text{ (in kcal/kg)}$$

With:

GE = gross energy (in kcal/kg)

CP = crude protein (in p.100)

FM = fat (in p.100)

CC = crude cellulose (in p.100)

NNE = non-nitrogenous extractive (in p.100)

Δt = correction factor for certain raw materials

Statistical analysis of data

All the parameters collected were entered into a Microsoft Excel spreadsheet to constitute a database. Frequencies were generated using Excel's pivot table method. Means and standard deviations of the parameters studied were obtained using the descriptive method of SPSS version 21 software.

RESULTS

Availability and quality of organic feedstuffs

Two hundred and twenty-three (223) samplings of organic raw material feeds were inventoried and analyzed (Tables 1 and 2). These feeds inventoried can be divided into six (6) groups according to their nature and nutritional profiles: cereals, cereal by-products, oilseeds, oilcakes, Animal source food and other non-conventional feed. Among these inventoried feeds, there are those that are primarily energy-rich and those that are primarily protein-rich.

Potentially energy-rich feeds were more diversified than potentially protein-rich feeds (Table 1). Except for rice bran, sesame and peanut seeds, most of the organic feed's material inventoried and analyzed had acceptable crude cellulose contents that could qualify them as single concentrated feeds (Table 1). Peanut, sesame and soybean seeds had fairly good crude protein (CP) contents, ranging from 21.88% to 36.34%, with relatively high fat and crude cellulose (CC) contents of 17% to 37% and 13.7% to 24.08% respectively. Among the four (4) types of oilseed meal identified and analyzed, it was the expeller-processed cotton cake (cotton cake pellets) that had the lowest CP content (24.62% CP), while its CC content was over 15% (15.95%). Local fish remains and dried chenille were the organic raw materials in the study that were richest in crude protein (Table 1).

Table 1. Organic nutrient composition of inventoried raw feed materials

Feeds profiles	Feeds categories	Feed ingredients		DM (%)	CP (%)	CC (%)	FM (%)	GE (kcal/kg DM)
Energic	Cereals	Yellow corn grains	Means	93.33	10.39	2.24	5	4765.47
			Maximum	93.97	11.57	4.09	7	4939.34
			Minimum	92.69	9.21	0.39	3	4591.6
				N (15)	N (15)	N (15)	N (15)	N (15)
		White corn grains	Means	93.47	9.62	2.19	7	4469.79
			Maximum	94.41	11.09	3.72	9	4632.76
			Minimum	92.53	8.15	0.66	5	4306.82
				N (13)	N (13)	N (13)	N (13)	N (13)
		Millet grains	Means	93.65	11.18	1.22	6	4490.42
			Maximum	94.58	12.04	1.95	6	4696.39
			Minimum	92.72	10.32	0.49	6	4284.45
				N (6)	N (6)	N (6)	N (6)	N (6)
		White sorghum grains	Means	93.75	10.42	1.94	5	4499.27
			Maximum	94.76	12.59	3.72	7	4603.47
			Minimum	92.74	8.25	0.16	3	4395.07
				N (7)	N (7)	N (7)	N (7)	N (7)
		Red sorghum grains	Means	93.32	9.46	0.66	5	4511.95
			Maximum	94.38	11.62	1.08	5	4555.37
			Minimum	92.26	7.3	0.23	5	4468.53
				N (6)	N (6)	N (6)	N (6)	N (6)
	Cereals sub-products	Wheat bran	Means	91.92	15.25	5.76	6.07	4765.47
			Maximum	93.86	16.98	8.2	8.07	4939.34
			Minimum	89.98	13.52	3.31	4.07	4591.6
				N (24)	N (24)	N (24)	N (24)	N (24)
		Industrial corn bran	Means	92.17	12.28	4.71	10	4893.94
			Maximum	94.36	15.21	7.24	14	51212.34
			Minimum	89.98	10.43	2.18	6	4575.54
				N (14)	N (14)	N (14)	N (14)	N (14)
		Local corn bran	Means	91.34	13.28	5.41	10	4523.97
			Maximum	95.57	15.55	8.54	15	4677.04
			Minimum	87.11	30.14	2.28	5	4370.9
				N (7)	N (7)	N (7)	N (7)	N (7)
		Rice bran	Means	90.93	7.84	27.42	6.1	4629.04
			Maximum	97.39	10.46	35.75	6.5	5007.19
			Minimum	84.47	5.22	19.09	5.7	4250.89
				N (6)	N (6)	N (6)	N (6)	N (6)
		Millet bran	Means	93.32	13.43	2.54	8	4734.99
			Maximum	94.31	15.14	4.36	8	5141.67
			Minimum	92.33	11.72	0.72	8	4328.31
				N (3)	N (3)	N (3)	N (3)	N (3)
		Local sorghum bran	means	94.03	10.13	2.96	10	4851.04
			maximum	95.06	14.42	3.47	10	5063.14
			minimum	93	5.84	2.45	10	4638.94
				N (3)	N (3)	N (3)	N (3)	N (3)
	Others	Parkia biglobosa pulp	Means	90.08	4.8	8.69	1.01	4411.22
			Maximum	91.96	6.89	9.68	1.31	4504.56
			Minimum	88.2	2.71	7.7	0.71	4317.88
				N (5)	N (5)	N (5)	N (5)	N (5)
Proteinic	Protein-oilseed grains	Groundnuts	Means	96.62	31.55	24.08	36	6664.21
			Maximum	96.94	33.2	26.04	46	7276.71
			Minimum	96.3	29.9	22.12	26	6051.71

			N (6)	N (6)	N (6)	N (6)	N (6)
	Sesame seeds	Means	96.56	21.88	19.01	37	6384.11
		Maximum	98.21	24.88	22.76	53.8	7346.31
		Minimum	94.91	18.88	15.26	20.2	5421.91
			N (7)	N (7)	N (7)	N (7)	N (7)
	Cowpea seeds	Means	93.11	27.26	1.83	4	4523.97
		Maximum	94.32	30.87	2.5	6	4677.04
		Minimum	91.9	23.65	1.16	2	4370.9
			N (6)	N (6)	N (6)	N (6)	N (6)
	Soya beans	Means	91.56	36.34	13.71	17.1	4629.04
		Maximum	93.35	44.2	20.77	19.4	5007.14
		Minimum	89.77	28.48	6.65	14.8	4250.89
			N (6)	N (6)	N (6)	N (6)	N (6)
Cakes	Cottonseed cakes, decorticated extraction	Means	91.22	43.17	7.51	11	4511.95
		Maximum	93.28	45.45	12.07	9	4555.37
		Minimum	89.16	40.89	2.95	13	4468.53
			N (11)	N (11)	N (11)	N (11)	N (11)
	Cotton seed cake, unhusked, ex-pellet	Means	94.14	24.62	15.95	11	4961.11
		Maximum	95.49	27.67	21.78	14	5176.78
		Minimum	92.79	21.57	10.12	8	4745.44
			N (51)	N (51)	N (51)	N (51)	N (51)
	Peanut cake	Means	95.65	42.76	11.51	16	5461.52
		Maximum	97	45.37	14.44	25	5917.07
		Minimum	94.3	40.15	8.58	7	5005.97
			N (5)	N (5)	N (5)	N (5)	N (5)
	Soya cake	Means	92.25	38.98	9.04	14	4734.99
		Maximum	93.49	44.73	15.03	16	5141.67
		Minimum	91.01	33.23	3.05	12	4328.31
			N (8)	N (8)	N (8)	N (8)	N (8)
Feeds of animal origin	Remaining fish from local fishing	Means	94.86	54.81	1.15	13	5635.07
		Maximum	95.57	62.31	1.71	18	5831.55
		Minimum	94.15	47.31	0.59	8	5438.59
			N (11)	N (11)	N (11)	N (11)	N (11)
	Dried Chenille	Means	93.73	55.50	6.32	17.47	5635.07
		Maximum	96.23	56.81	7.28	19.47	5831.54
		Minimum	91.23	54.19	5.36	15.47	5438.6
			N (3)	N (3)	N (3)	N (3)	N (3)

DM: dry matter, CP: Crude protein, CC: Crude cellulose, FM: Fat matter, GE: Gross energy, N: number of samples.

Table 2. Mineral nutrient composition of inventoried organic feeds

Feed profiles	Feed categories	Feed ingredients	CA (g/kg DM)	P (g/kg DM)	Ca (g/kg DM)	Cu (mg/kg DM)	Zn (mg/kg DM)
Energic	Cereals	Yellow corn grains	23.6±5.1 N (15)	11.71±7.79 N (15)	0.59±0.12 N (15)	3.53±0.63 N (15)	6.5±1.22 N (15)
		White corn grains	28.1±9.5 N (13)	8.78±2.94 N (13)	0.72±0.25 N (13)	1.88±0.51 N (13)	11.28±1.18 N (13)
		Millet grains	25.9±7.3 N (6)	9,0±6.3 N (6)	0.74±0.05 N (6)	10.30±5.02 N (6)	31.03±8.17 N (6)
		White sorghum grains	36.3±10.1 N (7)	12.26±4.46 N (7)	1.09±0.79 N (7)	6.25±2.93 N (7)	4.53±2.25 N (7)
		Red sorghum grains	25.5±3.9 N (6)	10.37±3.27 N (6)	0.71±0.08 N (6)	6.55±0.71 N (6)	23.5±0.71 N (6)
	Cereal sub-products.	Wheat bran	55.5±15.01 N (24)	7.65±3.12 N (24)	4.53±0.42 N (24)	10.35± 4.79 N (24)	74.94±11.77 N (24)
		Rice bran	44.6±15.4 N (6)	12.6±1.68 N (6)	2.74±0.51 N (6)	4.33±0.58 N (6)	4.2±0.1 N (6)
		Industrial corn bran	56.9±9.3 N (14)	9.43±1.93 N (14)	1.06±0.61 N (14)	4.44±1.07 N (14)	29.57±12.54 N (14)
		Local corn bran	178.1±26.6 N (7)	21.2±1.52 N (7)	1.2±0.53 N (7)	12.72±1.21 N (7)	34.38±8.98 N (7)
		Millet bran	36.8±16.4	9.57±2.99	1.36±0.64	11.33±8.08	33.00±4.58

			N (3)	N (3)	N (3)	N (3)	N (3)
		Local sorghum bran	67.8±35.6 N (3)	11.69±2.68 N (3)	1.29±0.28 N (3)	5.00±1.00 N (3)	20.66±1.53 N (3)
	Others	Parkia biglobosa pulp	54.2±7.4 N (5)	4.38±2.81 N (5)	2.05±0.35 N (5)	63.35± 14.86 N (5)	56.36±13.89 N (5)
Proteinic	Grains	Cowpea seeds	24.1±1.4 N (6)	11.43±7.87 N (6)	2.18±0.32 N (6)	8.46± 1.19 N (6)	43.16±10.95 N (6)
		Soya beans	61.2±35.6 N (6)	3.4±02.01 N (6)	2.6±3.0 N (6)	12.74±6.21 N (6)	44.04±7.72 N (6)
		Peanuts	50.02±8.6 N (6)	9.98±6.8 N (6)	1.22±0.25 N (6)	18.60±14.73 N (6)	43.93±15.98 N (6)
		Sesame seeds	63.6±5.4 N (7)	15.51±9.13 N (7)	13.91±4.48 N (7)	19.88±11,86 N (7)	65.83±7.57 N (7)
	Cakes	Cottonseed cakes, decorticated extraction	80.9±7.5 N (51)	6.95±4.62 N (51)	3.48±0.38 N (51)	8.25±3.77 N (51)	38.66±14.81 N (51)
		Cotton seed cake, unhusked, ex-pellet	54.1±8.1 N (11)	7.77±3.32 N (11)	2.24±0.22 N (11)	13.93± 4.39 N (11)	54.26± 16.52 N (11)
		Soya cakes	44.6±3.3 N (8)	4.73±0.92 N (8)	2.6±1.06 N (8)	15.86±6.99 N (8)	46.94±8.16 N (8)
		Peanuts cakes	68.8±8.3 N (5)	11.71±8.94 N (5)	1.22±0.1 N (5)	21.25±7.1 N (5)	37.75±11.62 N (5)
	Feeds from animal origin	Remaining fish from local fishing	198.3±60.2 N (11)	31.79±15.62 N (11)	37.19±10.29 N (11)	19.00± 14.15 N (11)	66.00±43.93 N (1)
		Dried Chenille	55.5±7.6 N (3)	9.18±2.41 N (3)	1.79±0.27 N (3)	90.00±0.71 N (3)	103.12±2.14 N (3)

CA: crude Ash, P: Phosphorus; Ca: calcium; Cu: copper; Fe: iron; N: number of Samples

Table 3. Composition of the main mineral sources available and used in the manufacturing of poultry feed

Sources minérales	P (g/kg DM)	Ca (g/kg DM)	Cu (mg/kg DM)	Zn (mg/kg DM)	Fe (mg/kg DM)
Oyster shells	0.6±0.12 N (5)	355.0±31,62 N (5)	2.01±0.55 N (5)	9.85±1.42 N (5)	2785±50 N (5)
Shell mixture	2.23±0.71 N (5)	69.38±27.63 N (5)	ND	ND	ND
Limestone	1.77±0.45 N (6)	63.82±28.00 N (6)	ND	ND	ND
Bone powder	135.2±23.44 N (6)	374.4±139.40 N (6)	152.07±29.19 N (6)	191.11±53.98 N (6)	569±12,3 N (6)

ND: Undetermined

Almost all of the organic ingredients identified and analyzed were richer in phosphorus than in calcium (Table 2). Copper (Cu) levels in cereal samples ranged from 3.53 to 10.3 ppm (mg/kg DM), and zinc (Zn) levels from 4.53 to 23.5 ppm (mg/kg DM). Copper levels in cereal bran fluctuated between 4.33 and 12.72 ppm. Zinc levels varied between 20.66 and 74.94 ppm. Their zinc content ranged from 20.66 to 74.94 ppm. Copper levels in protein-oil seeds ranged from 8.46 to 19.88 ppm, and zinc levels in these products from 43.16 to 65.83 ppm. The husked-expeller cotton cakes had higher copper and zinc contents than the non-husked-expeller cotton cakes. Indeed, the copper and zinc contents of the husked-expeller cotton cake were 13.93±4.39 and 54.26±16.52 ppm, respectively, compared to 8.25±3.77 and 38.66±14.81 ppm for the non-husked-expeller cotton cake. The remains of locally caught fish and dried chenille presented balanced mineral content (Table 2).

Availability and quality of mineral-based raw material feeds

Among the four (4) main mineral sources analyzed (Table 3), bone meal proved to be the most interesting in terms of mineral nutrient content, concerning the major elements as well as the trace elements analyzed. Furthermore, it was observed that the mixture of shells and limestone was relatively richer in phosphorus compared to oyster shells.

DISCUSSION

Due to their high energy content, cereals and their bran remain the most widely traded raw materials for poultry feed (Swidiq *et al.*, 2012; Atchade *et al.*, 2019; Negash, 2022). Indeed, some studies (Ahiwe *et al.*, 2018; Atchade *et al.*, 2019) report that cereals account for between 70% and 90% of energy intake in poultry feed, compared with around 35% to 50% for protein intake. Corn, millet and sorghum grains and their bran have similar chemical values and can therefore be substituted at any time in the formulation of poultry rations (Ouattara *et al.*, 2014; Negash, 2022). The choice between the two categories of feeds could be based on availability and market price. The results of chemical compositions of inventoried organic raw food materials demonstrate that peanut, sesame, and soybean seeds contain interesting concentrations of CP. However, their fat content (FM) remains relatively high. This would further highlight the importance of always processing these seeds before use, either by pressing or by transforming them into oilcakes. However, their relatively high crude cellulose content could be explained by the fact that they were analyzed with their husks intact, without preliminary husking (Luithui *et al.*, 2019). Moreover, for these seeds, it is always recommended to proceed by roasting or hulling methods in order to reduce the impact of the anti-nutritional factors they usually contain (Larbier and Leclercq, 1992; Berger *et al.*, 2015; Luithui *et al.,* 2019). Indeed, these authors report that for most of these seeds, anti-nutritional factors such as antitrypsin factors (ATF) strongly reduce monogastric growth by disrupting protein assimilation and pancreatic function. Roasting before feeding to animals not only removes the possibility of moisture or other contaminants, but also makes the grains more digestible and palatable to them (Larbier and Leclercq, 1992; Ouattara *et al.*, 2014).

Unlike hulled cottonseed meal (Peller), the unshelled cottonseed meal (expeller) inventoried in this study has an average crude cellulose content slightly higher than the recommended 15% for a feed that would qualify as a concentrate (Nagalakshmi *et al.*, 2007; Swiatkiewicz *et al.,* 2016). In fact, it has been proven that cotton seed cake production techniques have a significant impact on their crude cellulose content (Nagalakshmi *et al.*, 2007; Diaw *et al.*, 2011; Swiatkiewicz *et al.*, 2016). Overall, the chemical characteristics of the other oilseed meals analyzed (dehulled cottonseed cake, peanut cake, soybean meal) remain very advantageous for poultry feed (Larbier and Leclercq, 1992; *Bastianelli et al.,* 2005; Nie *et al.*, 2025). However, due to the presence of free gossypol, it is recommended that poultry rations incorporate no more than 10% of cottonseed cake (Bougouma-Yameogo *et al.*, 2007). Above this dose, and on an empirical basis, ferrous sulfate should be added, as it can neutralize the biological effects of gossypol (Bougouma-Yameogo *et al.*, 2007; Nie *et al.*, 2025).

Most of the basic organic raw feed materials inventoried and analyzed during this study were revealed to be richer in phosphorus than in calcium. This observation could be justified by the fact that these feeds included cereals and their by-products, as well as oilseeds and their derivatives. Indeed, literature data show that these types of products frequently presented more interesting phosphorus than calcium contents (INRA, 1989; Rivière, 1991; Vanisha *et al.*, 2011). This could further explain why, when using these diets in poultry feed, it is always necessary to have an additional source of calcium in order to balance the phosphorus-calcium ratio, which determines metabolic efficiency and skeletal quality (Quiniou *et al.,* 2019). An adequate diet must cover calcium and phosphorus requirements throughout the animal's life.

The phospho-calcium ratio in the feed is therefore all the more important to take into account when calcium and phosphorus levels are low, or when one of the two elements is in low concentration in the feed (Quiniou *et al.*, 2019).

The better nutritional qualities of shelled cottonseed cake in terms of mineral elements, particularly trace elements such as zinc and copper, compared with unshelled cottonseed cake, provide clear evidence that this type of cake is still the most recommended for poultry feed.

Several studies already conducted (Rivière, 1991; Noziere *et al.,* 2018) show that the mineral content of oyster shells is often lower than that of other mineral sources such as seashells and bone powder In Burkina Faso, given the size of the livestock population, bone powder is a source that could be better valorized.

CONCLUSION

The results of the survey show that, for poultry feed, it is easier to find energy and diversified feeds on the market than protein feeds. Cereals and their bran are still the most popular raw materials for poultry feed in Ouagadougou. Oilseeds and their derivatives are also sold on the market for poultry feed. Other apparently unconventional feeds such as *Parkia bigobosa* powder and dried chenille are also sold on the market for poultry nutrition.

Apart from the rice bran and the sesame and peanut seeds, most of the feedstuffs inventoried and analyzed had acceptable crude cellulose contents, enabling them to be qualified as single concentrated feeds. Almost all of the raw feed materials analyzed were richer in phosphorus than in calcium. Among the mineral sources analyzed, bone powder proved to be the most interesting in terms of mineral nutrient content, for both the major elements and trace elements analyzed.

The data obtained from the present study can be used to create local reference for available raw feed materials. The results of food chemical composition could also serve as a guidance for the animal feed industry and government personnel responsible for controlling and inspecting feed quality at the national scale.

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