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Proximate analysis of poultry and fish feed ingredients in Madhya Pradesh and Chhattisgarh states

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Abstract
The present study was carried out to determine the proximate composition of various poultry and fish feed ingredients in the feed samples obtained from the feed lots supplied to Phoenix Poultry, and several poultry and fish farmers or feed suppliers of Madhya Pradesh and Chhattisgarh states. The samples were subjected to proximate analysis, the parameters studied were percentage of moisture, crude protein, crude fat, crude fiber, total ash nitrogen free extract and acid insoluble ash. The data generated after proximate analysis was expressed as lest square means and standard errors of each proximate principles for each feed ingredients. The results of proximate analysis revealed that higher moisture content was recorded for fish meal, whereas higher crude protein, crude fat and crude fibre content were observed in maize gluten, rice polish and de-oiled rice bran, respectively. For proximate principles total ash and acid insoluble ash, higher mean values were recorded for fish meal and whereas maize shown higher content of nitrogen free extract. Proximate composition of the examined poultry and fish feed ingredients was in accordance to feed specification mentioned by Bureau of Indian Standard, which indicating that feed ingredients were of optimum quality.

Keywords: Crude fat, crude protein, feed samples, proximate analysis, nutrients

Introduction
Poultry and fishery are one of the essential components of Indian economy, since these sectors provide source of income to the small scale and marginal farmers. These sectors not only ensure the livelihood people living in poverty but the food security as products of this industry is relatively an economical source of protein (Hasan *et al.*, 2022) [6]. India ranks third in egg production and fifth in broiler meat production globally (Index Mundi, 2021; APEDA, 2023) [7, 2]. Poultry is one of the fastest-growing sectors in India, growing with an annual rate of 8 to 10 percent approximately (APEDA, 2023) [2], similarly, India is the third largest country in terms of global fish production, whereas second in aquaculture production (DOF, 2023) [5].
Nutrition plays a pivotal role in livestock farming because its directly affects the profitability in terms of survivability, growth and production. The development livestock depends various factors *viz*., on the feed quality, water, breeds, environmental conditions, management and the farming practices (Ofori *et al.*, 2019) [9]. Among all these factors, feeds are the most valuable. In livestock enterprise, feed cost appears to be one of the major constraints against the greater expansion, contributing to 60-80% of the economic cost input in rearing commercial livestock such as poultry or fishery. The nutrient balance of feed influences feed utilization and growth. Improper protein and energy levels disturbs the calorie: protein ratio in feed and not only increases production cost but also chances of various metabolic disorders. Insufficient energy with respect to protein content in diets causes protein waste due to the increased proportion of dietary protein used for energy. Similarly excess energy in diet with respect to protein causes subcutaneous fat deposition, difficulty in mobilization and reproduction etc. (Pond *et al.*, 2005; Al-Mahmud, 2012) [10, 8].
Proximate analysis is a worldwide followed method for feedstuff analysis which was suggested by Wilhelm Henneberg and Friedrich Stohmann in 1865 at Weende in Gottingen, Germany. In this method nutrients present in a feed sample are expressed in terms of six broad proximate principles i.e., water (moisture), ether extract (EE), crude fibre (CF), crude protein (CP), total ash and nitrogen free extract (NFE). This method is simple and yet descriptive gives an idea about the approximate nutritive value of a feedstuff without actually using it in a feeding trial. That's the reason, why it is still significant even after 100 years of its discovery (Reddy, 2016) [11].

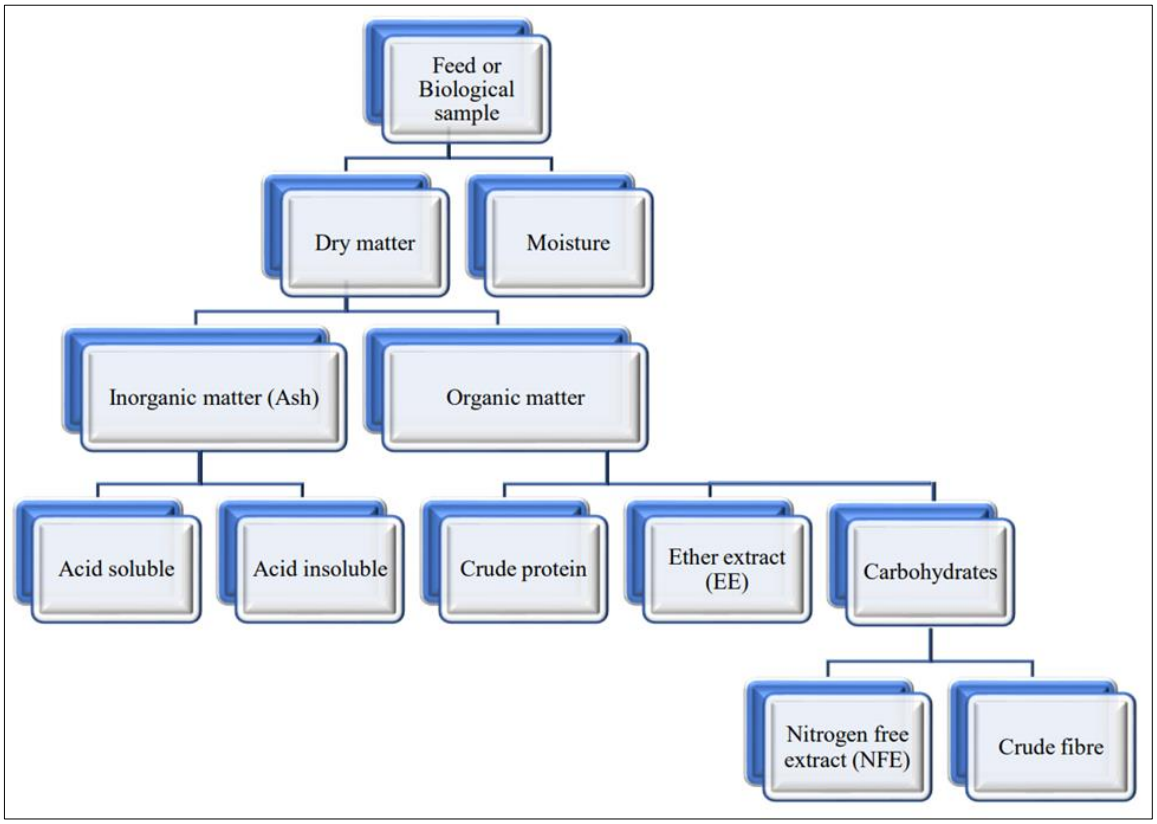

Fig 1: Weende's system of proximate analysis

There is not enough information available about the nutrient composition of various feeds consumed by poultry and fishes in the country. A very scant work is published, which can give an insight into the proximate composition of the poultry and fish feed ingredients available in India. In view of above, the present study was conducted to estimate the proximate composition of some poultry and fish feed ingredients in Madhya Pradesh and Chhattisgarh States.

Materials and Methods

Laboratory Sample Preparation

Collection and preparation of samples: The feed samples were collected from the feed lots supplied to Phoenix Poultry, and several poultry and fish farmers or feed suppliers of Madhya Pradesh and Chhattisgarh states during the years 2000 to 2012. Phoenix Poultry is a premier hatchery of South East Asia, established in 1972. It caters the need of a day-old layer and broiler chicks of Madhya Pradesh and its neighboring states. It has its own feed analysis laboratory and was established in the year 2000. A total 1563 out of 1647 different feed ingredients were collected during the period of year 2000-2012. From farmers, samples of feed ingredients were collected directly when they brought the feeds samples to the laboratory for analysis. The sample of each feed ingredient was grounded using mixer and grinder into small particle size (0.2 mm mesh size). After that the samples were stored in dry and well covered plastic bottles until analysis.

Method of proximate analysis: Proximate analysis of feed was made as per AOAC (2002) [1]. These analyses show the moisture, crude protein, crude lipids, ash and carbohydrate content of the sample. The analysis of proximate composition was done in the Phoenix Laboratory, Jabalpur (M.P.). On each chemical analysis, duplicate determinations were carried out.

Determination of moisture and Dry matter: Moisture contents in the feed were determined by AOAC (2002) [1] and Dry matter of the feed was estimated by drying the feed in hot-air oven at 100-105 ºC till constant weight. The percentage of the moisture content in the sample was calculated by the following formula.

$$\text{Moisture (\%)} = \frac{\text{(Weight of original sample-Weight of dried sample)}}{\text{Weight of original sample}} \text{x100}$$

Dry matter (%) = 100-Moisture (%)

Determination of crude protein: Nitrogen in the samples was estimated by Micro Kjeldhal method and multiplied by the factor 6.25 to get value of crude protein.

$$\text{Nitrogen (\%)} = \frac{\text{Value of } H_2SO_4 \text{ X 0.1 X 0.014}}{\text{Weight of sample}} \text{x100}$$

Crude Protein (%) = Nitrogen (%) X Conversion factor

Where, conversion factor for animal and plant origin is 6.25 and 5.90, respectively.

Determination of crude fat: Fat is examined with low boiling organic solvent (petroleum ether 40-60 ºC) by Soxhlet extraction and the extract thus obtained weighted after recovery of the solvent. Crude fat was determination through Soxhlet extraction technique. The crude fat (%) was calculated by using the following formula.

$$\text{Crude fat (\%)} = \frac{\text{Corrected weight of fat}}{\text{Weight of sample}} \text{X100}$$

Determination of Ash: It was estimated by igniting the sample in the muffle furnace at 600-650 ºC. Ash content of each feed was estimated by following incineration method.

$$\text{Ash (\%)} = \frac{\text{Weight of Ash}}{\text{Weight of sample}} \text{X100}$$

Determination of crude fibre: Crude fibre was estimated by successive boiling fat free sample with 1.25% Sulphuric acid solution and then with 0.25% sodium hydroxide solution. The crude fiber content of feed ingredients was then determined according to the following formula.

$$\text{Crude fibre (\%)} = \frac{\text{(Wt. of crucible dried residue) – (Wt. of crucible with ashed sample)}}{\text{Wt. of original sample}} \text{ X 100}$$

Determination of nitrogen free extract (NFE): Nitrogen free extract (NFE) was determined by the difference between the original weight of the sample and sum of the weights of its moisture, crude protein (CP), crude fat (CF), ash and crude fiber as determined by their appropriate analysis.

Carbohydrate (%) = 100 - (Moisture + Ash + Crude protein + Crude fat)

Statistical Analysis: The data generated was analyzed using computer software XLSTAT Version 2023.1.6. For each feed ingredient different proximate constituents were expressed as least square means and standard errors.

Results and Discussion

The results of proximate analysis of all the feed ingredients under study has been presented in table 1. The nutrient composition in all the feeds were found within the range Indian standard for various poultry and fish feeds (BIS, 2007; BIS, 2014) [3, 4]. Moisture content (%) in the feeds examined varied from 7.35±0.31 to 13.01±0.62. The higher moisture content was observed in fish meal, whereas, lower moisture content was observed in maize gluten. Therefore, higher dry matter content (%) was recorded for maize gluten and lower for fish meal i.e., 92.65±0.31 and 86.99±0.62, respectively (Table 1). The moisture content depicts the amount of water present in feeds. More will be the moisture in the feeds, greater will be the chances that microorganism and fungi will contaminate and deteriorate the feeds. From economic and management point of view, moisture content is important in estimating the cost per unit weight of feeds as well as storage of feeds.

Table 1: Proximate composition of feed ingredients (% Dry matter Basis)

Feed Ingredients		Moist	DM	CP	Crude Fat	Crude Fibre	Total Ash	NFE	AIA
Soya Bean Meal	Mean ± SE	10.60±0.08 (648)	89.40±0.08 (648)	49.29±0.07 (648)	1.38±0.14 (27)	6.00±0.15 (81)	8.73±0.21 (38)	47.16±0.32 (99)	1.45±0.06 (648)
	Range	6.08-17.50	82.49-99.71	38.88-57.53	0.63-3.81	4.42-12.49	7.18-12.85	39.20-60.10	0.12-14.21
Maize	Mean ± SE	12.02±0.11 (235)	87.98±0.12 (235)	9.33±0.03 (235)	4.00±0.23 (3)	1.76±0.14 (3)	1.48±0.18 (3)	83.38±0.59 (3)	0.07±0.04 (3)
	Range	8.03-16.85	83.15-98.30	8.08-12.03	3.57-4.37	1.53-2.04	1.28-1.31	82.35-84.40	0.02-0.04
Ground Nut Cake (GNC)	Mean ± SE	7.64±0.20 (101)	92.36±0.20 (101)	42.85±0.25 (101)	5.99±0.27 (79)	10.86±0.51 (30)	3.36±0.17 (25)	36.71±0.87 (25)	1.45±0.09 (101)
	Range	4.21-17.34	82.66-95.79	37.33-50.43	0.37-8.67	4.58-17.33	2.32-5.88	28.34-45.95	0.34-7.87
De-Oiled Rice Bran (DORB)	Mean ± SE	10.71±0.15 (104)	89.29±0.16 (104)	15.02±0.16 (104)	1.36±0.39 (5)	13.22±0.34 (104)	---	---	5.06±0.23 (24)
	Range	5.60-14.76	85.24-94.40	8.27-19.88	0.50-2.44	3.49-26.21	---	---	3.13-7.18
Rice Polish	Mean ± SE	9.54±0.09 (249)	90.46±0.09 (249)	12.52±0.07 (249)	15.77±0.10 (767)	6.14±0.27 (103)	7.11±0.16 (57)	57.46±0.48 (57)	1.38±0.11 (57)
	Range	5.77-15.67	84.33-94.23	7.77-16.08	1.45-26.52	0.83-19.14	4.82-10.21	49.02-72.14	0.29-4.96
Mustard Oil Cake	Mean ± SE	8.57±0.15 (19)	91.43±0.15 (19)	38.59±0.59 (19)	8.87±0.70 (19)	---	---	---	---
	Range	7.64-9.78	90.22-92.36	31.65-41.93	0.83-13.95	---	---	---	---
Maize Gluten	Mean ± SE	7.35±0.31 (34)	92.65±0.31 (34)	56.06±0.6 (34)	5.96±0.24 (34)	0.27±0.11 (2)	---	---	1.14±0.58 (3)
	Range	4.45-10.71	89.29-95.55	46.54-61.51	3.84-10.16	0.16-0.39	---	---	0.51-2.32
Fish Meal	Mean ± SE	13.01±0.62 (29)	86.99±0.62 (29)	50.00±1.77 (29)	5.74±0.20 (29)	1.53±0.46 (15)	37.16±0.74 (22)	---	9.09±1.51 (29)
	Range	5.80-21.12	78.88-94.19	31.58-63.12	3.84-9.07	0.11-5.50	32.67-48.81	---	1.56-32.19

DM = Dry Matter, CP = Crude Protein, NFE = Nitrogen Free Extract, AIA = Acid Insoluble Ash; Figure in the parenthesis is total no. of sample.

Crude protein includes true protein and non-protein nitrogen (NPN). It is obtained indirectly by estimating the nitrogen content of the feed and multiplying it with 6.25. The results of proximate analysis revealed that crude protein content (%) in the examined feed samples varied from 9.33±0.03 to 56.06±0.6. Lower estimate of crude protein was for maize and higher was maize gluten. As expected, protein supplement feeds *viz*., soybean meal, ground nut cake, mustard oil cake, maize gluten and fish meal showed higher crude protein content than energy supplement feeds i.e., maize, de-oiled rice bran and rice polish (Table 1). Usually, feedstuffs of leguminous plant origins show higher protein content than non-leguminous. Protein is the major structural elements in the body of animals therefore it is very crucial nutrients to quantify and considered as first nutrient. It is one of the costliest nutrients to supply and deficiency of it severely affects production. For efficient utilization of protein, it should be balanced with energy in the diet so as to maintain energy to protein ratio. When the crude protein content is below optimum, the gut microbes are not able to digest the feeds efficiently (Hasan *et al.*, 2022) [6].

The fat content in the feed is estimated by extracting a feed sample in a Soxhlet apparatus for 8-16 hours. This extract not only contains true fats i.e., glycerides of fatty acids but also pseudo-fats like cholesterol, free fatty acid, resins and volatile oils. Therefore, this whole extract is usually called as ether extract or crude fat (Reddy, 2016) [11]. Various poultry and fish feeds had different crude fat contents analyzed. Among

all examined feed ingredients crude fat content (%) varied between 1.36±0.39 to 15.77±0.10 (Table 1). The lower and higher crude fat content were recorded for de-oiled rice bran and rice polish, respectively. Since, fat contains concentrated energy, therefore, dietary inclusion of them affects feed efficiency growth rate. However, they also increase the palatability of diet and quality of pellet.

Crude fibre is mainly composed of various polysaccharides such as cellulose, hemicellulose and lignin. The crude fibre is determined by subjecting the fat free residual feed to successive refluxing treatments with 1.25% solutions of sulphuric acid and sodium hydroxide. The organic residue remained after ignition of the dry matter is the crude fibre. The Crude fibre content (%) in examined feed ingredients was found within the range of 0.27±0.11 to 13.22±0.34. De-oiled rice bran showed the higher crude fibre content i.e., 13.22±0.34, whereas maize gluten showed the lower crude fibre content i.e., 0.27±0.11. Usually, roughage feedstuffs possess more than 18%, whereas, crude fibre while concentrate possess less than 18% crude fibre (Reddy, 2016) [11]. In the present study, all the feed ingredients were concentrates, that was the reason why crude fibre content was below 18% in all (Table 1).

Results of analyzed total ash (%) contents of the collected feed samples were within the range of 1.48±0.18 to 37.16±0.74. Whereas, total acid insoluble ash (%) was recorded between 0.07±0.04 to 9.09±1.51 (Table 1). The main purpose of determining total ash is to calculate nitrogen free extract by difference. It gives an apparent idea about the mineral contents of feedstuffs. However, ash may not be a measure of total inorganic matter present, because some organic carbon may be bound as carbonate, and some inorganic elements such as Chlorine (Cl^-), Iodine (I^-), Iron (Fe^{2+}), Sulphur (SO_4^{2-}), Selenium (Se^{2-}) and Sodium (Na^{2+}) may be lost due to combustion (Reddy, 2016) [11].

Nitrogen free extract is a heterogenous mixture of components that includes fractals, organic acids, pectins, pigments, starch and sugars. The results of proximate analysis of feed ingredients in present study revealed that ground nut cakes were lower in nitrogen free extract (%) i.e., 36.71±0.87, whereas higher NFE % were revealed by maize grains i.e., 83.38±0.59. (Table 1).

Conclusion

The growth, production, reproduction and health of poultry birds and fishes rely on the availability of quality nutrients with adequate amount. In present study, all the feed ingredients varied among various proximate principles. However, they were meeting the level of Indian standards specified for poultry and fish feeds, which was showing that feed ingredients were of optimum quality.

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Conflict of interest

Authors declare no competing interest.

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