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TRACE ELEMENTS AND OTHER ESSENTIAL NUTRIENTS OF BIOLOGICAL MATERIALS

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Several samples of poultry feeds, feed components, animal fodders were analysed for nutrients such as ash, protein, fat and trace elements, Fe, Cu, Mn and Zn. Among the feeds, blood meal contained the highest amount of protein (80.59%) and the lowest was in bone meal (20.95%). Similarly, the lowest amount of fat was in bone meal (0.53%) and the highest in meat meal (14.13%). Concentrations of essential trace elements in feed components widely varied and were, however, adequate in the poultry rations studied. Among the local fodders berseem had the highest values for protein (26.31%), fat (2.18%) and ash (15.73%). Fodder bajra was generally poor in these nutrients. Local fodders differed markedly in the concentrations of Fe, Cu, Mn and Zn. Among the imported and local fodders, Hasavi-rushad and berseem respectively contained higher amounts of Fe, Cu, Mn and Zn.

INTRODUCTION

In addition to organic growth factors such as carbohydrates, fats, proteins and vitamins, small concentrations of certain elements also are essential for the health of plants and animals (Under-wood 1977; Sattar and Khalid, 1979). After grains, domesticated animals or birds are the second important source of human food. The competition between animal feed and human food is becoming a cause for sociopolitical concern. In the early days of feed industry, the majority of raw materials used were by-products of flour milling and oil extraction industries. As animal production became intensive, the highest quality raw materials were employed, many of them competing directly with human food. In view of such competition, each raw material in an animal feed has a specific "economic value" which is related to its nutritional composition. The classical

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Atwater energy conversion factors of 4 Kcal/g of food protein and carbohydrates, and 9 Kcal/g of food fat are adequate for computation of the energy contents of customary diets (NRC, 1974). The dietary allowance of energy, protein and the trace elements have also been suggested (NRC, 1971; FAO, 1974). However, the ruminant pattern of nutrition and intermediary metabolism differs in some respects from the usual monogastric animals. The energy inputs of ruminants are derived from grass and they are unable to use glucose as a source of carbon for lipogenesis (Leveille, 1970). Although studies on some fodders and nutrient levels of various food materials have been reported (Sattar and Chaudry, 1978; Sattar *et al.*, 1982), the data on the trace element and other nutrient levels of our feed components and fodders are lacking. The objective of the work reported here was to study the distribution pattern of trace elements and other dietary essential nutrients in some major feed components and fodders utilized in Pakistan.

MATERIALS AND METHODS

Samples of poultry feeds and feed components were obtained from a local feed manufacturing company (Ghazi Feeds, Faisalabad). New fodders, imported from Saudi Arabia, and the local ones grown under normal irrigated soil conditions were utilized. In the case of imported and local fodders, the samples were water washed, and oven dried before analysis. Chemical analyses of the ground samples were carried out using standard procedures. Ash percentage was determined in a muffle furnace at 550°C; protein by micro-kjeldahl distillation and fat by Soxhlet extraction methods (AOAC, 1984). After wet digestion of the feed and plant samples with $HNO_3/HC1O_4$, Fe, Zn, Cu and Mn were determined by atomic absorption spectrophotometer, Beckman model 485, using the method of O'Dell *et al.* (1972) modified for macro-levels (Sattar and Chaudry, 1978).

RESULTS AND DISCUSSION

Protein, fat, ash and trace element contents such as Fe, Zn, Cu and Mn of selected feed components are presented in Table 1. Blood meal contained the highest amount of protein (80.59%) followed by that of meat meal (55.04%). The lowest protein percentage (20.95) was in the bone meal. The highest amount of fat was in meat meal (14.13%), the lowest in the bone meal

Table 1. *Protein, fat, ash and selected trace element contents of some feed components*[1].

Feed Material	Protein (%)	Fat (%)	Ash (%)	Fe	Zn	Cu	Mn
				ppm			
Meat meal	55.04±1.32	14.13±1.73	29.62±0.92	6589.3±165.2	111.8± 6.85	9.5±0.7	136.0±10.7
Blood meal	80.59±3.50	3.27±0.27	8.71±0.52	3021.7±198.0	82.1±15.3	7.9±1.2	39.3± 9.4
Fish meal	53.02±6.82	7.90±0.50	35.19±2.14	4711.7± 60.1	63.9± 1.0	28.7±0.7	100.6± 7.6
Bone meal	20.95±0.04	0.53±0.06	66.37±2.27	7774.7± 55.4	267.9±38.5	63.6±8.3	169.9± 3.1
Rapeseed meal	39.02±0.17	7.24±0.00	9.98±0.07	1329.3± 49.2	72.6± 2.7	13.5±0.5	48.7± 2.1
Cottonseed cake	33.38±0.22	7.24±1.24	8.52±0.18	94.1± 0.4	66.8± 0.7	20.5±1.6	11.1± 0.5
Popy cake	34.60±0.30	4.88±0.68	14.45±0.54	1522.0± 83.2	113.1± 2.5	26.0±0.8	147.1± 1.6

1 : Dry matter basis; averages of 2-4 determinations.

(0.53%), and the intermediate amounts (3.27-7.90%) in other feed components. Bone meal had relatively higher values for ash (66.36%) as compared with other samples, possibly due to higher levels of Ca and P in the bone ash. The significance of Ca and P as a part of body's skeletal framework is readily apparent. Ash representing total mineral element levels constitutes little more than 3% of the animal body (O'Dell *et al.*, 1972), which is deceptively small figure in contrast to their importance. Bone meal was also rich in other trace elements, Fe, Zn, Cu and Mn. Among the seed-cakes (rapeseed, cottonseed and popy cakes), popy cake had highest values for Fe (1522.0 ppm), Zn (113.1 ppm), Cu (26.8 ppm), and Mn (147.1 ppm). The list of required elements has grown from 16 to 21 in the last 14 years. Required dietary needs have been established for relatively few of the essential elements (NRC, 1971; NRC, 1974;).

The protein, fat, ash and trace elements content of some poultry rations are shown in Table 2. Brioler starter and chick starter contained higher amounts of protein, ash and trace elements as compared to broiler finisher, obviously due to higher dietary requirments during the growth period. The rations studied seem to have enough quantities of protein and the micro-elements for meeting protein and mineral requirements of poultry. Although the data on the nutrient levels of basic feed components used in this country are lacking, some studies have reported protein and trace element levels of various food and feed sutuffs (Sattar *et al*, 1982). Under practical conditions, a substantial difference in the protein needs for finishing male and female briolers has been observed; however, for maintaining live performance and permitting subtle alterations in carcass quality, 22% and 20% of protein for the male and female, respectively was regarded sufficient (NSC 1973).

Protein, fat, ash and trace elements of various grasses and fodders are given in Table 3. Comparative composition data revealed that Hasavi rushed contained more of protein and ash as compared to other fodders. Among the local fodders, berseem had the highest values for protein (26.31%), fat (2.18%) and ash (15.73%). Fodder bajra was generally poorer than others in these nutrients. The concentration of trace elements also markedly differed in these fodders. Among the local fodders, berseem contained more of Fe, Zn, Cu and Mn than others, whereas in the case of imported fodders, there was no definite

Table 2. *Protein, fat, ash and selected trace element contents of feeds*[1].

Feed Material	Protein (%)	Fat (%)	Ash (%)	Fe	Zn	Cu	Mn
				ppm			
Chick starter	23.19±0.79	3.24±0.44	10.40±0.49	1648.4±96.9	87.1±20.6	60.9±1.1	72.5±0.0
Brioler starter	22.63±1.00	3.98±0.38	10.65±0.60	1476.9±87.9	65.3± 1.4	51.4±1.4	68.1±7.0
Brioler finisher	20.60±0.39	4.87±0.67	7.81±0.40	673.7±29.8	38.8± 0.5	46.3±2.1	45.2±0.2
Layer supper	15.92±0.70	3.98±0.78	11.11±0.53	1510.2±90.0	44.8± 0.9	49.7±1.7	81.2±2.8

1 : Dry matter basis; averages of 2-4 determinations

Table 2. *Protein, fat, ash and selected trace element contents of fodders*[1].

Feed Material	Protein (%)	Fat (%)	Ash (%)	Fe	Zn	Cu	Mn
				ppm			
a) *Improved*							
Hasavi alfalfa	23.36±0.08	2.80±0.02	19.10±0.25	950.6± 38.8	15.7±0.8	7.3 ±0.3	87.6± 3.5
Hasavi rushad	29.22±0.08	2.64±0.06	18.86±0.01	603.9± 26.6	35.9±1.6	6.10±0.3	877.8±38.7
Beet	21.60±0.17	2.47±0.06	14.09±0.05	549.4± 31.1	28.2±1.6	11.3 ±0.66	147.1± 8.3
Radish	24.64±0.08	2.73±0.06	11.51±0.06	1406.9± 71.6	25.9±1.3	4.3 ±0.2	106.5± 6.4
Ryegrass Italian	20.63±0.06	4.58±0.11	12.65±0.34	720.5± 29.9	26.2±1.1	11.9 ±0.5	87.8± 3.6
Hijazi lucerne	21.86±0.23	2.53±0.08	15.17±0.97	599.1± 0.1	34.5±2.0	8.2 ±0.5	51.3± 0.8
b) *Local*							
Swank	12.49±0.49	3.50±0.10	14.25±0.00	455.5± 74.6	29.2±6.6	9.4 ±0.7	—
Kallar grass	16.61±0.06	2.84±0.00	9.48±0.60	418.1± 26.7	48.7±3.1	11.4 ±0.7	63.7± 4.1
Lucerne	19.68±0.08	1.66±0.09	13.62±0.13	577.9± 37.2	46.5±2.9	12.4 ±0.8	48.9± 3.1
Berseem	26.31±0.08	2.18±0.14	15.73±0.10	2203.8±140.9	87.1±5.6	22.3 ±1.4	104.8± 6.7
Sorghum	13.28±0.10	1.03±0.05	14.24±0.21	1177.5± 12.9	42.3±0.5	10.1 ±0.3	98.6± 1.1
Bajra-joint	7.22±0.04	0.85±0.04	7.41±0.21	404.2± 31.1	18.1±1.7	9.2 ±0.9	61.1± 3.3
Bajra-dwarf	4.25±0.06	1.06±0.04	7.12±0.02	372.9± 16.6	46.6±0.8	4.9 ±0.1	47.4± 1.3
Guawara	13.43±0.37	0.96±0.02	6.61±0.58	449.6± 30.3	21.5±0.2	7.4 ±0.1	32.1± 0.9
Maize	10.69±0.25	0.20±0.01	8.08±0.02	611.9± 32.4	30.3±0.7	7.63+0.0	75.5± 0.4

1 : Dry matter basis ; averages of 2-4 determinations.

relative uptake pattern for the elements studied. Hasavi-rushad had the highest value for Mn, 877.8 ppm, than the range value, 32.1-147.1 ppm, of Mn found for other fodders. Nutritive values of some tropical grasses and forage crops have been reported with special reference to their protein content (Holm, 1976) and for other essential nutrients (Sattar *et al.*, 1982; Rahman, 1986). The variations in the concenrations of these elements are attributed to the effects of soils, condition of growth water, supply, time of sowing, time of cutting, fertilizers as well as varietal differences. Trace element contents of kallar grass as a function of different salinity levels have been reported (Sandhu *et al.*, 1981). Mineral requirements reorted (NRC, 1971) for dairy cattle indicate that these fodders have adequate levels of the nutrients needed by the animals. Interestingly, the kallar grass which is a good colonizer of saline and water logged soils was quite comparable in these nutrients to many of the other fodders. The data on the composition of fodders for essential nutrients are not available in this country. Therefore, evaluation of our local food, and feed stuffs, in quantitative terms, for dietary essential nutrients, could be of value to agriculture planners, for maximum production of milk, meat and mutton.

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