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Research Article

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Elemental Ratio and Their Importance in Feed and Fodder

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ABSTRACT

The economic viability of animal husbandry depends on the genetic potential for production, good health care, balanced feeding of animals and efficient marketing of the produce. Since genetic improvement and health care are important for sustainability, whereas efficient feeding and marketing will help in increasing the profitability. However, the profitability is directly dependent on the sources of feed and fodder, as about 65-70% of the total cost of livestock farming is attributed to feeding. Any saving in feed and fodder cost would directly contribute to increase in profitability. Balanced feeding of animals is more critical, as the results are reflected within a short span, almost immediately, in the form of milk and meat production. Hence feeding of animals has greater significance for livestock holders. Therefore suitable feeding system should be developed with the local feed resources with supplement of nutrient so as to achieve optimum production. Keeping this in view the present investigation was carried out.

Here some common well adapted fodder species (Cenchrus ciliaris, Cenchrus setigerus, Lasiurus Sindicus, and Penniesetum Typhoideum) were taken from Jodhpur district of Rajasthan for their elemental ratio investigation..

All the Minerals such as Ca, Mg, and K, were found adequate to meet the NRC requirements, whereas S and P were found near critical level. Mineral ratio such as C/N, C/P, N/P, N/S, and Ca/P, of plant samples were found between 29.16 – 40.67, 168–222.63, 4.78–5.76, 4.22–7.2 and 3.56–5.79(% DM) respectively. Grass Tetany ratio K/(Ca+Mg) was ranged between 0.27 to 0.40 on miliequivalent basis.

Keywords: *Mineral Imbalance, Palatability, Digestibility, Grass Tetany, Elemental Stoichiometry.*

INTRODUCTION

Animal husbandry is a major source of livelihood security and economic activity in arid, semi-arid and harsh ecosystem of Rajasthan[1]. Apart from being an important source of human nutrition, livestock is also a source of crop nutrition, power for agricultural tillage and rural transportation and a valuable asset, which can be easily encashed during emergencies. A wide range of products generated from livestock enable farmers to add their sources of income and absorb risk. Efficiency and productivity of animal solely depends on the nutritional status of their feed .Balanced feeding of animals is key factor for their utmost utilization .Just keeping this in view the present study was carried out .

Several studies have been carried out on nutrient evaluation of vegetation of arid species[2, 3, 4, 5,and 6]., but there is scanty information regarding the elemental ratio and their importance in feed and fodder webs.

Minerals are vital for normal growth, reproduction; health and proper functioning of the animal's body. Minerals protect and maintain the structural components of the body, organs and tissues, and are constituents of body fluids and tissues as electrolytes. Minerals catalyze several enzymatic processes and hormone systems; maintain acid-base balance, water balance and osmotic pressure in the blood and cerebral spinal fluids. Mineral imbalance has bad impact on forage quality[7]. Excessiveness of one element cause antagonistic effect for other elements and thus causing mineral imbalance. Mineral imbalances may arise singly or various combinations. Imbalance of macro elements i.e. Ca, P, Mg, Na, may cause rickets, lameness, milk fever, lambing, sickness, tetany, reduced appetite[8], while deficiency of trace elements i.e.

Co, Cu, Mn, Se, I, Zn may cause ill thrift, abortion, placental retention, lamb death, reduced immunity in calves, infertility, susceptibility to bacteria and parasites and poor skin/hair/fleece, quality[9]. Signs of mineral imbalance/deficiencies are often non-specific and in cases of marginal deficiencies may go unnoticed by the stock owners. The interpretation of such signs is also difficult if more than one mineral is deficient or the deficiency is associated with other disorders such as increased burdens of gastrointestinal parasites, especially since trace element deficiencies may increase the susceptibility of animals to disease.

Utilization of low quality roughages such as hays, straws and stovers could also be further limited by their low contents of macro and micro minerals due to their effects on rumen microbial growth and activity, leading to lowered feed digestibility[10].

There is limited information about the mineral ratio of forages of this region despite of its importance in livestock production, and very little has been done to establish levels of supplementation of these feed resources for enhanced nutrition of grazing ruminants in arid and semi-arid areas of Rajasthan. This elemental stoichiometric evaluation would be useful to suggest mineral supplementation strategies to improve growth and reproductive efficacy of cattle's for Rajasthan as well as other countries with similar climate and ecological conditions.

MATERIAL AND METHODS

The study was carried out with four different forage grasses *Pennisetum Typhoideum, Cencherus Ciliaris, Cencherus setigerus and Lasiurus sindicus* collected from Central Arid Zone Research Institute, Jodhpur situated in hot arid zone of western Rajasthan (26° 17' 12" N / 73° 1' 48" E).

Sampling and preparation of samples are done by internationally accepted method[11]. About 500 g fresh Matured plant leaves were collected from the C.A.Z.R.I, campus, Jodhpur. Individual contaminations were removed by thorough washing under running tape water followed by rinsing with distilled water, dried at 60°-70^{O}C in a well ventilated oven or plant sample dryer till constant weight .The dried plant tissues are usually grinded in a grinder. Finely grinded plant tissues passed through 100 mesh sieve. The grinded sample kept in air tight polythene container such as plastic bottles with screw cap to prevent adsorption of water from the humid environment and stored.

All the parameters were estimated by internationally accepted method. Total nitrogen is determined by kjeldahl method. For Sulfur determination sample is digested in binary acid mixture (HNO_3+$HClO_4$) and determined turbid metrically[12]. For calcium and magnesium estimation dry ashing of plant sample after treatment with dilute H_2SO_4 and alcoholic solution is done and Calcium and magnesium are determined in plant test solution by EDTA titration method[13]. Phosphorous is determination by spectrophotometrically by Vanadomolybdate method[14]. Sodium and potassium is determined in plant digestions sample by Flame Photometer[15]. Carbon content was determined using Walkey and Black method[16]. Mineral ratio such as C/N, C/P, N/P , N/S and Ca/P were calculated in % of dry Matter. Grass tetany ratio K/(Ca+Mg) was calculated in miliequivalent basis[17]. Statically analysis is also carried out according to Snedecor and Cochran [18].

RESULTS AND DISCUSSIONS

The Mineral concentration with NRC requirement of forage grasses have been presented in Fig.1.The Calcium concentration (% DM) varied from 0.79 in *Cencherus. Ciliaris* to 1.20 in *Pennisetum Typhoideum.* Calcium is an important mineral for beef cattle, both in terms of the relative requirement and the diversity of functions in the body. It is a major component of the skeleton, which also serves as a calcium storage site. In fact, about 99% of the total calcium in the body is found in the bones and teeth. Calcium is involved in blood clotting, muscle contraction, transmission of nerve impulses, regulation of the heart, secretion of hormones, and enzyme activation and stabilization[19].

Magnesium is closely related to calcium and phosphorus in function and distribution in the body. This mineral is known to activate at least 300 different enzymes. Magnesium is essential in energy metabolism, transmission of the genetic code, membrane transport, and nerve impulse transmission. The concentration of Magnesium was also found adequate as per NRC, requirement for lactating beef cattle[20]. Ruminants are generally at risk from hypomagnesaemia when the forage contains less than 0.2% of Mg

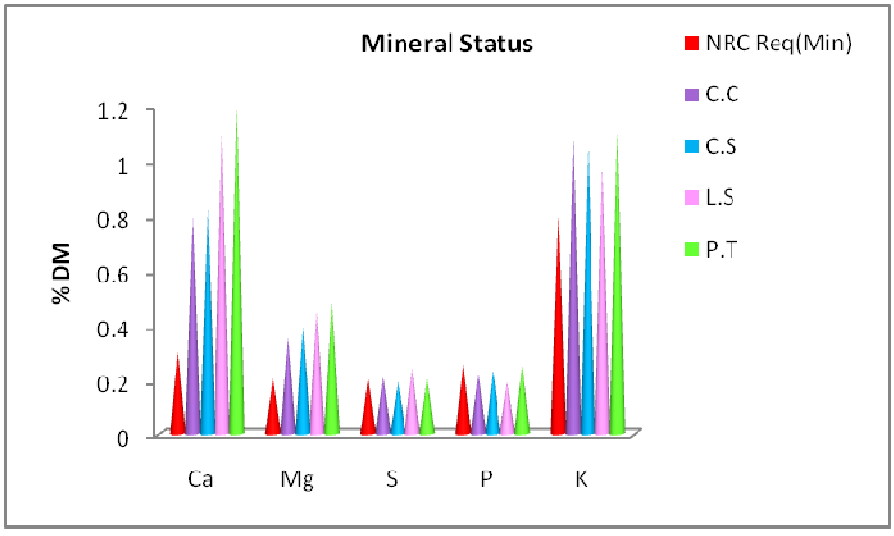
and high in K content. Magnesium is considered to be an important factor in the occurrence in grass tetany in animals[8].

Phosphorous is essential for strengthening the skeleton, teeth, improving blood plasma, assimilation of carbohydrates, fats protein synthesis and necessary for enzyme activation. Phosphorus is also required by ruminal microorganisms for growth and cellular metabolism. Its deficiency causes poor growth and development of animals[19]. Phosphorous is the most limiting mineral to productivity of grazing animals throughout the world because of low availability to range plants and loss through soil erosion. The estimated value of Phosphorous from the forages was ranges from 0.19 % (*Lasiurus sindicus*) to 0.25 % (*Pennisetum Typhoideum*) which is just touching the critical level of the requirement for cattle as per NRC requirement[20].

Potassium (K) is the third most abundant mineral in the body. It is important in acid-base balance, regulation of osmotic pressure and water balance, muscle contractions, nerve impulses, and certain enzyme reactions [21]. The data revealed that all the forages were richer in Potassium in comparison to other macro elements analyzed here. Almost all the forages screened, had adequate levels of Potassium as compared to its requirement of NRC[20]. The higher concentration of K may be due to its selective uptake from the soil and was much higher than Na. Similar findings were also reported by Singh et al[22].

Sulfur is needed for synthesis of methionine and cystine, which are sulfur-containing amino acids, as well as the B vitamins, thiamin, and biotin. Sulfur is required by ruminal microorganisms for normal growth and metabolism[23]. In fact, ruminal microorganisms are capable of synthesizing all organic sulfur containing compounds required by the animal from inorganic sulfur. Sulfur concentration was estimated in the samples found nearly adequate, because it is transferred to seed protein[24]. It was found minimum (0.19%) in *Cencherus setigerus* and maximum (0.24) in *Lasiurus Sindicus* (Fig.1). The variation in S content of plants depends largely on the amount of S in plant protein in the form of S containing amino acids.

Fig.1: Mineral Status in some selected forage species



C, N and P are respectively the third fourth and sixteenth most abundant elements in our solar system and often is the main constituent of any ecological material. Carbon is the basic building block of life and is a source of energy, whereas nitrogen and phosphorous are also necessary for such things as proteins, genetic material, and cell structure. Ribosomes are the protein manufacturing machinery in all living cells and are needed in great abundance for rapid cellular proliferation. Thus, high levels of rRNA (and the availability of P-rich food to elevate production of rRNA) is a necessity for anabolic synthesis for an animal's biomass production and their rapid growth. There is no atmospheric reservoir of P and so there is no alternative source once phosphate runs out. Therefore, P is the ultimate limiting nutrient whereas N is the proximate limiting nutrient [25].N and P share common valence state and are closely associated with both cytoplasmic and nucleic materials, including cell membranes, nucleic acids, ATP, ADP and NADP.

N and P are essential to both individual organisms and entire ecosystems. The actual elemental ratios offered to terrestrial grazers that feed on vascular plants and foliage should be measured with high accuracy, and grazers may adjust their distribution and food selection to balance their qualitative and quantitative demands.

Animals maintain homeostasis in body nutrient composition, and that consequently, the rates and ratios of nutrient recycling reflect the imbalance between their body and their diet with direct implications for ecosystem nutrient recycling[26]. Variation in C: N: P ratios in living things reflect underlying allocations to major molecules (e.g., RNA, cellulose), and chemical structures (e.g., bone and antlers) are closely associated with key traits such as growth rate, size, and trophic position. Furthermore, stoichiometric imbalances between adjacent trophic levels in food webs have large effects on the rates and efficiencies with which energy and elements are processed in ecosystems.

The C: N: P ratios thus seem to have an important role in controlling trophic relationships, structure of food webs and species composition in communities in terrestrial ecosystems. Food with a low P: Carbon (C) ratio can be a low-quality food for mammals[27].

C to N ratio is one of the main quality indicators for anaerobic biomethane process for biogas and composting strategy. Moretto and Distel experienced that leaves of the palatable grasses are higher in N concentration while lower in C/N ratio and lignin concentration than those of the unpalatable grasses[28]. Higher C: N ratio reduces digestibility and finally feed intake.

It is relatively common that food P: C ratio for herbivores in nature is lower than expected thresholds for P limitation[29].Thus, animals perform best when the biochemical composition of the food is completely balanced with respect to the animal's requirements.

The importance of N and P hinges on the fact that these elements are major constituents of amino acids and nucleic acids, respectively, and thus a deficiency in these elements may directly translate to reduced protein synthesis and growth. N: P stoichiometry has tight connections with food-web nutrient cycling .As an example, in freshwater systems, N: P stoichiometry has an important impact on species composition, productivity, nutrient limitation and trophic structure. When referred to the N: P ratio of large organisms, it is inevitable to consider the proportion of mechanical component since mechanical structure investments begin to dominate with increasing body size. The larger the organism, the greater the reliance on C (for food) or calcium (Ca) and P (for bone) N: P stoichiometry is a powerful tool used in feed-web study on the basis that there exists an imbalance between the homeostatic N and P composition of the consumer and its feed

The principle behind this is that organisms must increase their allocation to P-rich rRNA in order to meet the elevated demand for protein synthesis required for rapid growth. N: P ratio and growth rate are thus linked via the intimate connections between P allocation to ribosomes and N allocation to protein synthesis[30]. Greater allocation to P-rich rRNA is possible under low N: P environmental ratios. These conditions allow high growth rates and thus favor species with higher growth rates [31].

Minor changes in the C: N: P composition of herbivores can be associated with significant changes in the nutritional quality of their prey. Commonly faster-growing plants had higher RNA contents, higher N and P contents and lower protein: RNA ratios, but not consistently lower N: P ratios.

Calcium (Ca) is closely associated with P metabolism in the formation of bone, and a Ca: P ratio of 2:1 is usually recommended for ruminant diets. Ca/P contents of the plant species ranged between 3.56% (*Cencherus Setigerus*) to 5.79% (*Lasiurus Sindicus*). Ca/P ratios of all species, were higher than 2.00 (Fig. 2). When Ca/P ratio is over 2.00, milk fever may be observed in animals or growing Performance and effectiveness of forage-animal product transformation may decrease , Under such condition calcium and phosphorous supplementation should be balanced in the diet of animals for their proper utilization in the animal system[19, 32] .

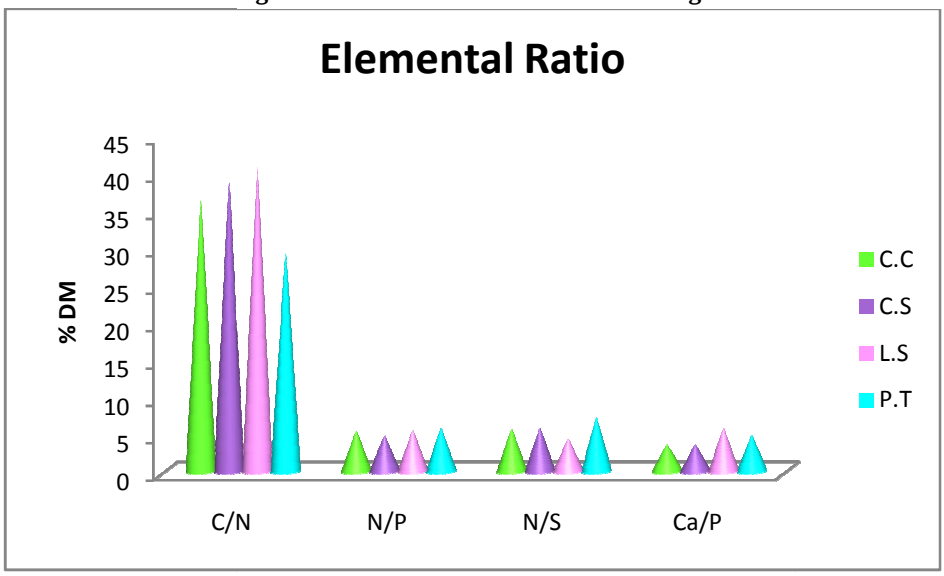
Metabolism of nitrogen and sulphur is closely integrated and commonly expressed as N: S ratio. Dijkshoorn *et al* proposed using the ratio of N to S in plant material as a guide to diagnosing S deficiency[33]. The optimum ratio of forage for ruminants is considered to be 10:1 or less. Forages are the important source of Sulphur to ruminants. When they contain N: S ratio wider than 10:1, ruminants fed on

them adjust by wasting nitrogen resulting in a decreased efficiency of feed protein utilization[34]. Therefore knowledge of N: S ratio of forage is essential for proper formulation of feeding schedule.

N/S ratios of examined samples ranged between 4.33 (*Lasiurus Sindicus*) to 7.2 (*Penniesetum Typhoideum*) (Fig. 2). N/S ratios of all samples were found below 10:1 .

Potassium is mostly located in the intracellularly compartments, playing a synergistic role with sodium in cellular activity. K/ (Ca+Mg) ratios of plant species ranged between 0.63 (*Lasiurus Sindicus*) to 0.95 (*Cencherus Ciliaris*). It is recommended that K/ (Ca+Mg) ratio of forages should be below 2.20[35, 36]. The K/ (Ca+Mg) ratios over 2.20 may cause grass tetany in especially cool seasons. K/ (Ca+Mg) ratios of all species were found below 2.20.

Fig.2: Mineral ratio in some selected forage



CONCLUSION

Result showed considerable variation within and between species of grasses. Cereal crops (*Pennisetum Typhoideum*) distinguished itself with very high concentration of total Nitrogen, Ca, Mg, K, and N/S ratio and lower concentration of C/N and C/P ratio in comparison to grass species. Grass tetany ratio was found under limit. The concentration of Sulfur and phosphorous was found more or less identical.. Since these vegetations are evergreen and extensively distributed in this region, farmers of the area can very ideally use them as fodders, so suitable supplementary feed products should be incorporated with these fodder sources for higher livestock production.

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