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Relationship Between Buffering Capacity and Chemical Composition of Poultry Feedstuffs

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ABSTRACT

Five samples each of maize, deoiled rice bran, rice polish, wheat bran, soybean meal, limestone and dicalcium phosphate were collected from various sources and their proximate analysis was done. Each sample was grinded and suspended in distilled water and shaken with magnetic stirrer. The pH was recorded using a magnetic stirrer and the amount of 0.1 M HCl required to reduce the pH of the sample to 5 was measured as its B-value. pH and B-value were compared with the crude protein and ash content of the sample. The results showed that ingredients with high protein content had high B-value. B-value for lime stone and dicalcium phosphate were the highest. Knowing the B-value of the ingredients the B-value of the diet can be calculated.

Key words: pH, Buffering capacity, feeds, feed stuffs

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INTRODUCTION

The concept of manipulating stomach acidity by adding acid to feeds or using feeds of low acid-binding or buffering capacity has been around for a long time and addition of organic acids to broiler feeds is a common practice. However, there is little information on the buffering capacity (B-value) of ingredients that are used in formulation of complete feeds. Buffer action of any solution is its capacity to resist change in its pH when acid or alkaline solution is added to it. Buffering capacity is the amount of 0.1 M HCl required to reach a pH of 5(Bolduan *et al,*1988).

Poultry diets usually have high alkalinity characteristics .Vegetable proteins and calcium carbonate in feeds have a strong buffer. The use of diets characterized by such a high buffer capacity can compromise the intestine capability to keep an acidity level that can support growth and in some cases, maintain beneficial intestinal micro flora. Many harmful bacterial species have growth around pH 7, whereas useful bacterial species such as *Lactobacillus* and *Enterococcus* have their best growth at pH around 6. Poultry intestinal tract acidification allows modulation of the intestinal bacterial flora in a positive and natural way and, at the same time, it works against the multiplication of that bacterial flora that besides being harmful and dangerous for the animal health can represent a problem of legal nature connected to the feed stuffs health.

In proventriculus, gastric juice is secreted. This lowers pH in between 2.0 to 4.0. A low gastric pH is important to activate pepsin from pepsinogen, which digests protein. Fermentation of undigested protein by microbes leads to formation of toxic biogenic amines. Low gastric pH controls bacterial population. In the acid environment, pathogenic bacteria such as *E.coli* and *Klebsiella* species as well as bacteroids diminish. Beneficial bacteria, such as *Bifido* and *Lactobacilli* species are more tolerant towards low pH values. In young animals, capacity to secrete gastric juice is limited. High B-value may pose problems of multiplication of pathogenic bacteria. The recommended B-value for poultry is about 1-10 for first 10 days of age and 10-20 for 11-30 days age (Makknick, 2001). It may not be possible to reduce B-value of feed sufficient low. Keeping in view the present study was undertaken to measure the Buffering capacity of feeds commonly fed to poultry.

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MATERIALS AND METHODS

Five samples each of maize, deoiled rice bran, rice polish, wheat bran and soybean meal were collected and analysed for proximate principles (AOAC, 1990). pH of each sample was measured by suspending 10 g of fully grinded feed ingredient in 100 ml of distilled and deionised water and stirred continuously with a magnetic stirrer. Digital pH meter was used for recording the pH. Initial pH of the feed sample was recorded and then titration was done using 0.1M HCl till the pH of 5 obtained. Initial pH and all further readings were taken after equilibrium of 3 minutes.

B-value of each sample was calculated as the amount of 0.1 M HCl required for lowering the pH of a feed to a pH of 5. Feed and ingredients with a pH less than 5 were titrated as above but against 0.1 M NaOH until pH 5 was obtained. B-values in these cases were given negative values. The data of proximate principles, ph and B-values was subjected to statistical analysis (Snedecor and Cocharan, 1989). Mean differences were compared by using Duncan Multiple Test (Duncan, 1955).

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RESULTS AND DISCUSSION

After procurement of 5 samples each of maize, deoiled rice bran, rice polish, wheat bran, dicalcium phosphate and limestone, all of them were analysed by the standard methods of AOAC (1990). pH and B value of the samples were studied simultaneously to know that they are correlated or not. By knowing the B-value of ingredients B-value of the diet can be formulated.

Variation in the proximate composition

In maize, all the proximate parameters differed significantly (P<0.05) with different samples. The average protein value of maize was 9.26±0.26 with pH of 6.94±0.02 and B-value of 2.95±0.53. The dry matter of deoiled rice bran varied significantly (P<0.05) with in samples but the crude protein content did not differ significantly. The crude fibre of sample 1 (13.87%) was more than all other samples but the ether extract was significantly less (Pd”0.05).The pH value of all the samples had a mean range of 5.47 to 5.60 but differed significantly(Pd”0.05) from each other. Similarly, the B-value of rice polish ranged between 5.55 for sample 1 and 5.85 for sample 2 which also differed significantly (Pd”0.05) from each other. The data regarding wheat bran indicated that crude protein, crude fiber, ether extract, total ash, pH and B-values of samples showed wide variation and differed significantly (Pd”0.05) among themselves. In soybean meal, crude protein , pH and B-values differed significantly (Pd”0.05) from sample to sample. pH and B-value of various samples of DCP and limestone powder differed significantly (Pd”0.05) from each other. The data indicated that the average pH and B-value of DCP was less than the limestone powder.

Correlation of pH and B-values with crude protein and ash contents

Crude protein and B-value of all the feed ingredients had significant correlation. The highest correlation was obtained for soybean followed by maize and wheat bran (Table 3). The pH and crude protein for maize and wheat bran had significant correlation of 0.65. Crude protein and pH for soybean meal had non significant relationship between them. Ash and pH showed a correlation of -0.85 for soybean meal. Correlation Coefficient between ash and pH of rice polish was though positive but non significant (0.46), with ash and B-value the correlation was negative (-0.17). Crude protein and B-value erere significantly correlated (0.64). Crude protein and pH did not gave positive correlation (0.34)

Initial pH and B-value for the various feed ingredients were similar to that obtained by Riverdin (2002) and Jasitis *et al* (1987). Cereals had lower pH as compared to the legumes and minerals had alkaline pH (Bolduan, 1988). Ash had basic effect, some ingredients showed positive correlation between ash and B-value but the results were non consistent for all ingredients.

Among all the proximate parameters crude protein was the best predictor of the pH and B-value which means ingredients with high protein content (pulses) have high pH and B-value as compared to the cereals. Protein content best explained the variation in B-value of feedstuffs was also found by Riverdin (2002).

A higher crude protein content generally increased the pH and B-value of the feed due to the buffering ability of the amino groups. The

Table 1. Percent chemical composition and B-value of feed ingredients.

Parameter	Maize	Deoiled Rice bran	Rice Polish	Soybean Meal	Wheat Bran
Dry matter	88.64±0.36	91.03±0.21	90.07±0.22	89.98±0.08	89.16±0.36
Crude protein	9.26±0.26	12.96±0.20	13.19±0.24	45.67±0.92	16.16±0.25
Crude fiber	2.32±0.08	13.01±0.32	8.76±0.46	5.67±0.89	11.20±0.14
Ether extract	3.80±0.20	1.21±0.10	3.60±0.18	1.89±0.67	4.03±0.09
Ash	1.90±0.14	3.41±0.01	1.61±0.01	6.12±0.34	5.74±0.18
pH	6.94±0.02	5.56±0.03	6.63±0.01	6.79±0.91	6.75±0.01
B-value	2.93±0.53	5.66±0.02	14.26±0.01	22.00±0.81	11.28±0.04

Table 2. pH and B-value of dicalcium phosphate and lime stone powder.

	Dicalcium Phosphate		Lime stone powder	
Sample	pH	B-value	pH	B-value
1	7.10±.02[a]	242±.01[a]	9.28±.01[a]	1710±.00[a]
2	7.23±.04[b]	241±.01[a]	9.48±.01[c]	1720±.03[a]
3	7.24± .01[b]	245±.07[b]	9.52±.02[d]	1725±.01[b]
4	7.31±.09[c]	243±.01[a]	9.42±.01[b]	1730±.02[d]
5	7.25±.03[b]	240±.02[a]	9.40±.01[b]	1728±.01[d]
Average	7.28±0.91	240±0.79	9.38±0.02	1720±1.02

Means with different superscripts in a row differ significantly at ($P<0.05$)

Table 3. Correlation of pH and B-values with crude protein and ash content of different ingredients.

Ingredient	pH		B-value	
	Crude protein	Ash	Crude protein	Ash
Maize	0 .65*	-0.50	0.88*	-0.39
Deoiled rice bran	0.45	-0.39	0.67*	0.34
Rice polish	0.34	0.46	0.64*	-0.17
Soybean	0.38	-0.85	0.97*	-0.48
Wheat bran	0.65	-05.02	0.88*	-0.396

*Shows significant correlation

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amount of fiber also contributes to feed B-value (Burney *et al,* 1983). This applies to the by-products' of the cereals like wheat bran and rice polish. The higher B-value of these feeds as compared with other energy feeds, was in part due to their high fiber content. The B-value of individual mineral additives depended on whether the sample was a carbonate or phosphate compound and also whether it was monobasic, dibasic or tribasic. The carbonates and dibasic or tribasic mineral additives were generally found to have higher B-value than phosphates or the more acid mineral additives.

CONCLUSION

The present study revealed that cereals had lower pH as compared to the legumes and minerals had alkaline pH. The cereals by products have higher B-values due to the increased fibre content. Protein, among all the proximate parameters is the best indicator of B-value. Minerals also show high B-values. If the B-values of ingredients are known the B-value of the diet can be formulated favouring proper digestion and growth performance.

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