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BIOGEOCHEMICAL CHARACTERISTICS OF EGGS OF BACKYARD POULTRY FROM BARITE MINERALIZATION, ANDHRA PRADESH, INDIA

L. Chandra Sekhar Reddy[1]*
*[*1]Department of Geology, Loyola College, Pulivendla-516390, Kadapa District, Andhra Pradesh, India*

Corresponding Author:
E-mail: chandrareddyloyola@gmail.com

Abstract: -
In the present study an attempt has been made for biogeochemical studies involving elemental distribution and interactions in backyard poultry eggs from Vemula barite mineralized area to determine their indicator characteristics and of their possible application in applied environmental geoscience. The samples of backyard poultry eggs of hen were collected systematically. Their physical properties like moisture, organic matter and ash content are determined which shows wide variations. Trace element analysis of these samples was carried out for Ba, Sr, Cu, Pb, Zn, Mn, Ni, Co, Cr, Fe Mg, and Al. the parameter Coefficient of Apparent of Organic Binding (CAOB) is calculated for each element for the eggs. Wide variations are observed in the distribution of chemical elements in backyard poultry eggs. Ba occupies first position in the sequence in all parts of the raw eggs both on ash weight and dry weight bases. The enrichment of Ba concentration in backyard poultry eggs may be due to the presence of barite mineral. Therefore backyard poultry eggs may ideally be used as tools for their possible application in mineral exploration. This study has given greater scope in biogeochemical orientation surveys, and in environmental studies.

Keywords: - *biogeochemistry, backyard poultry eggs, trace elements*

1. INTRODUCTION

Among the poultry birds, the chicken or the domestic fowl is the most important in India. They are generally maintained either as "backyard poultry" or a "caged system poultry". Backyard poultry includes small flocks of several kinds of birds such as chicken, hens, ducks, geese, turkeys and guinea fowls. These backyard fowls are kept in heneries. These fowls freely move about pecking small insects, grains in the surrounding habit during the day time. There is an enormous literature on nutritional (Underwood, 1971; Stadelman and Cotterill, 1973; North, 1978), and management (Romanoff and Romanoff, 1949; Stadelman and Cottrell, 1973; Mountney, 1976) aspects of poultry. Brooks (1983) states that birds serve as indicators in biogeochemical prospecting for mineral deposits. In the Sanskrit texts of ayurveda, the physico-chemical properties of the eggs of the birds such as swans, hens, peacocks and sparrows (Priyavrat Sharma, 1981) and excreta of hens and peacocks (Pardhasaradhi Sarma, 1979) and their curative properties for the treatment of different human diseases and disorders were described. The eggs of the hen are highly nutritive in value and are considered as rich sources of almost all nutrients. Eggs have become a staple of the diet where they are abundant and mostly they are taken in the boiled or cooked form in diet. Hence, in the present work an attempt is made to study both the raw and boiled eggs. This study deals with biogeochemical characteristics of eggs of backyard poultry with regard to its significance in applied environmental geochemistry.

2. STUDY AREA

The barite deposit of Vemula region (Lat. 14° 19' 00" - 14° 21' 00" N: Long 78° 22' 30" E) of Cuddapah District, Andhra Pradesh is included in the Survey of India toposheet No 57 J/7. The study area is about 65 Km from the district headquarter Kadapa/Cuddapah and 15 Km from Pulivendla the mandal headquarter. In this area the basaltic hills generally flat-topped and are bald at some places. Vemula barite deposit associated with basic intrusives occurs within the Vempalli stage of the Lower Cuddapah in the Southern part of the Cuddapah basin (Prasad and Prasannan, 1976). Barite occurs as veins, stringers and fissure fillings along the planes of fracture, fault planes and joints mainly in the traps. The barite occurrences in the traps are the most productive and the thickness of the veins varies from few centimeters to as much as 6m. The ore is usually in various shades of white and generally classified as snow white, white and off colour for use in industries. This area primarily consists of conglomerates, shales, basalts, dolomites and dolomitic limestones. Earlier workers have carried out in mineralogical (Murthy, 1950; Krishnan, 1953), geochemical (BorreswaraRao, 1968; Sen and Krishnamurthy, 1971 ;), biogeochemical (Raghu, 2001, ChandraskeharReddy, 2014) and hydrogeochemical (Chandrasekhar Reddy et al, 2012) point view.

3. SAMPLING AND ANALYTICAL TECHNIQUES

In the present work an attempt is made to study the elemental distribution and interactions in eggs of the hens of the backyard poultry of Vemula barite mineralized area to determine its significance in biogeochemical surveys. Eggs of the birds of backyard poultry of hen from Vemula barite mineralized areas were collected. About thirty eggs of different hens were collected for the purpose of sampling. Eggs were washed thoroughly with distilled water and the sample preparation was made individually for both raw and boiled eggs.

A. Raw Eggs

One dozen eggs were taken and their shells were separated and then crushed into small piece. Their edible parts (yolk and albumen) were collected separately in a beaker and mixed thoroughly. Another six eggs were taken and their three components viz., shell, albumen, and yolk were mixed thoroughly to represent whole egg. Thus, raw eggs were made into composite samples of three parts, viz., (a) shell, (b) edible part and (c) whole egg.

B. Boiled Eggs

Another dozen eggs were taken and boiled in tap water for forty five minutes. After boiling their shells were separated and then crushed into small pieces. Their edible parts (yolk and albumen) were separated and made individual sample for yolk and albumen. Some boiled eggs were taken and their three components viz., shell, albumen and yolk were mixed thoroughly to represent as a whole egg sample. Thus, the boiled eggs were made into composite samples of four parts viz., (a) shell (b) albumen (c) yolk and (d) whole egg. Moisture from the egg samples was eliminated by keeping them at 110°C in hot air oven for eight hours. Further, the organic mater from the moisture-free samples was eliminated at 500°C in a muffle furnace for three hours. These samples were digested in 2M HCl as suggested by Brooks (1972). These samples were analyzed for trace elements viz., Ba, Sr, Cu, Pb, Zn, Mn, Ni, Co, Cr, Fe, Mg, and Al by means of atomic absorption spectrophotometer (AAS).

4. RESULTS AND DISCUSSIONS

4.1 Moisture, Organic Matter and Ash Content

The parameters of moisture, organic matter and ash were calculated (Table.1) for raw and boiled egg sample components. From the data (Table.1) the following observations are made:

In raw eggs the highest amount of moisture content (70%) is recorded in edible part and lowest (2.40%) in shell. Organic matter is recorded as high (26.54%) in edible part and low (5.05%) in shell. Ash content is recorded as high (92.55%) in shell and low (3.46%) in edible part.

In boiled egg, highest amount of ash content (90.25%) is recorded in shell and lowest (0.90%) in albumen; and the highest amount of organic matter (48.50%) in yolk and lowest (5.05%) in shell; and moisture content is recorded as high (87.50%) in albumen and low (4.70%) in shell. Romanoff and Romanoff (1949) have reported that the percentage of moisture organic matter and ash in entire chicken egg is 65.6, 23.2 and 10.8 respectively; whereas in the shell 1.6, 3.3 and 95.1 respectively. Stadelman and Cotterill (1973) have reported that the percentage of water and ash in albumen is 88 and 0.8 respectively and in yolk 48 and 2 respectively. Romanoff and Romanoff (1949) also stated that the volume of albumen is twice than that of yolk, contains roughly two or three times as much water and only half as much solid matter.

Table.1 Moisture, Organic Matter and Ash content (in %) in Different Parts of Raw and Boiled Eggs in Vemula Barite Area

S.No	Name of the part	Moisture %	Organic matter %	Ash %
	Raw egg			
1	Shell	2.40	5.05	92.55
2	Edible part (yolk & albumen	70.00	26.54	3.46
3	Whole egg	64.95	24.12	10.93
	Boiled egg			
1	Shell	4.70	5.05	90.25
2	Albumen	87.50	11.60	0.90
3	Yolk	48.75	48.50	2.75
4	Whole egg	62.98	22.70	14.42

4.2 Elemental Analyses

The raw and boiled egg samples were analyzed both on ash weight and dry weight bases for twelve elements consisting of Ba, Sr, Cu, Pb, Zn, Mn, Ni, Co, Cr, Fe, Mg and Al by atomic absorption spectrophotometry (AAS) and the data is presented in Table.2 From the data the following observations are made. Different elements show their presence or absence (not detected) on both ash weight and dry weight bases in eggs of the backyard poultry.

1. On both ash weight and dry weight bases, the eggs show highest concentration of Ba followed by Sr in Vemula barite mining area reflecting the ore element.
2. All individual parts of raw and boiled egg samples show high concentration of Ba, Sr and Pb on ash weight basis than dry weight basis.
3. It has been identified that Ni is present in all parts of raw egg on both ash and dry weight bases; whereas in boiled egg Ni is present on dry weight.
4. Cr is present on ash weight basis in all parts of raw and boiled egg
5. Al, is concentrated only in the whole egg but not in its individual parts on ash and/or dry weight bases.
6. Both on ash and dry weight bases, Pb is not detected in raw egg samples

4.3 Trends of Elemental Distribution in Different Parts of Raw and Boiled Eggs

The sequence of the individual parts of both raw and boiled eggs is arranged in the decreasing order based on elemental concentration (Table.3). From the data the following observations are made:

Raw Egg

1. In case of elements like Ba, Sr, and Zn the concentration is less in shell than in edible pat (E>S), whereas the reverse trend (S>E) is observed in the case of Cu and Ni irrespective of ash and dry weight bases.
2. In case of elements like Ba, Sr, Pb, Zn and Cr the concentration is high in edible part than in shell (E>S) whereas the reverse trend (S>E) is observed in case of Cu, Mn, Ni, Co, Fe and Mg on ash weight basis only.
3. In case of elements like Ba, Sr, Zn, Fe and Mg the concentration is high in edible part than in shell (E>S) but the reverse trend (S>E) is noticed in egg samples in the case of Cu, Pb and Ni on dry weight basis.

Boiled Egg

1. It is noticed that the concentration of the elements like Ba, Sr, Pb is progressively decreasing from yolk to shell (Y>A>S) i.e inner most layer to outermost layer; whereas the concentration of Cu and Fe is progressively decreasing from shell to yolk (S>A>Y) irrespective of ash and dry weight bases.

2. Within the egg right from the inner most layer yolk, to the outer must one, shell, the distribution of Zn is strikingly showing a trend, Y>A>S. In contrast to this, a reverse trend, S>A>Y is shown by Cr.
3. It may be noticed that Y>A>S trend is found in the case of Ba, Sr, Pb and Co, in contrast to this, Cu, Mn and Fe exhibit the reverse trend i.e S>A>Y.

4. On dry weight basis only, the elements like Ba, Sr, Pb and Mg the concentration is progressively decreasing from yolk to shell (Y>A>S). In contrast to this, Cu and Fe the reverse trend (i.e S>A>Y).

4.4 Elemental sequences

The elements analyzed in backyard poultry eggs are arranged in sequence of decreasing order based on their absolute concentration on both ash weight and dry weight bases (Table.4). From the data, variations in the elemental sequences among the raw and boiled eggs on both ash weight and/or dry weight basis are observed as follows:

Raw Eggs

1. Ba occupies first position in the sequence in all parts of the eggs both on ash weight and dry weight bases
2. Ba>Fe>Sr>Zn>Pb>Mg is the sequence in shell and whole egg samples on ash weight basis; Ba>Fe>Sr>Mg is the sequence on dry weight basis.

Boiled Eggs

1. Mg>Ba>Sr is the sequence in shell; Ba>Sr is the sequence in yolk; Ba>Mg>Sr is the sequence in whole egg on both ash and dry weight bases
2. On dry weight basis, Ba>Sr>Mg>Fe is the sequence in albumen and yolk.

4.5 Coefficient of Apparent Organic Binding (CAOB)

Generally, elemental concentration is higher on ash weight basis than on dry weight basis. But in some cases, samples analyzed on dry weight basis showed high elemental concentration due to the influence of organic matter. Therefore, in order to study the effect of organic matter in trace element distribution and behaviour, certain samples were analyzed both on ash weight and dry weight bases and a biogeochemical parameter called "Coefficient of Apparent Organic Binding" (CAOB) is introduced in the present work. It is the ratio of the concentration of an element on ash weight basis (Caw) to the concentration of same element on dry weight basis (Cdw). Thus CAOB = (Caw) / (Cdw).

In the present study, the parameter CAOB is calculated for each element for both the raw and boiled eggs (Table.2). The CAOB values of all elements are arranged in decreasing order as shown in Table.4. From the data (Table.5) the following observations are made:

1. It may be seen that there are wide variations for CAOB for all elements. These variations may be attributed to the influence of organic matter in dry samples.
2. There is no systematic order of elements in case of CAOB. Because of the unusual properties of organic matter, it has extremely important effects on the chemistry of the trace elements. These effects include complexing of the trace ions by dissolved organic matter, resulting in increased mobility of the elements; adsorption or formation of organic compounds, resulting in immobilization and reduction to lower valence states, with resulting changes in chemical properties (Rose et al, 1979)

Table.3 Distribution of Elemental Concentration in Different Parts of Raw and Boiled Eggs

Raw Eggs	
Trend	**Elements**
a). E>S d) E>S	Ba,Sr, Zn
a) S>E d) S>E	Cu, Ni
a) E>S	Ba, Sr, Pb, Zn, Cr
a) S>E	Cu, Mn, Ni, Co,Fe, Mg
d) E>S	Ba,Sr, Zn Fe, Mg
d) S>E	Cu, Pb, Ni
Boiled Eggs	
a) Y>A>S d) Y>A>S	Ba, Sr, Pb
a) S>A>Y d) S>A>Y	Cu, Fe
a) Y>A>S	Ba, Sr, Pb, Zn, Co
a) S>A>Y	Cu, Mn, Cr, Fe
d) Y>A>S	Ba, Sr, Pb, Mg
d) S>A>Y	Cu, Fe
S = Shell; E = Edible part; A = Albumen; Y=Yolk; a)= Ash weight, d) = Dry weight	

Table.2 Trace Element Analyses (in ppm) in Backyard Poultry Eggs

Element	Raw Egg				Boiled Egg			
		Shell	**Edible part**	**Whole egg**	**Shell**	**Albumen**	**Yolk**	**Whole egg**
Ba	a)	2000	2300	3200	1250	1575	1820	2400
	d)	1870	2040	2500	550	1340	1590	2000
	c)	1.06	1.12	1.28	2.27	1.17	1.14	1.20
Sr	a)	1150	1290	1380	600	710	795	850
	d)	820	995	1100	502	590	674	725
	c)	1.40	1.29	1.25	1.19	1.20	1.17	1.17
Cu	a)	772	715	750	152	120	58	51
	d)	610	312	414	200	150	68	30
	c)	1.26	2.29	1.81	0.76	0.80	1.25	1.70
Pb	a)	825	1015	1200	510	624	685	715
	d)	496	418	350	65	82	150	275
	c)	1.66	2.42	3042	7.84	7.60	4.56	2.60
Zn	a)	854	1000	1200	3.18	690	718	770
	d)	315	612	320	1.70	65	218	310
	c)	2.71	1.63	3.90	1.87	10.61	3.29	0.8
Mn	a)	18	10	26	25	18	12	10
	d)	ND	ND	ND	ND	ND	ND	22
	c)	-	-	-	-	-	-	0.45
Ni	a)	75	8	24	ND	ND	ND	ND
	d)	39	15	50	60	72	17	28
	c)	1.92	0.53	0.48	-	-	-	-
Co	a)	795	65	700	310	715	762	214
	d)	375	426	494	20	60	190	410
	c)	2.12	1.52	1.41	1.40	11.91	4.01	0.52
Cr	a)	10	12	14	49	42	29	25
	d)	ND	ND	ND	ND	ND	ND	ND
	c)	-	-	-	-	-	-	-
Fe	a)	1800	275	1650	350	320	290	264
	d)	1600	1700	1792	480	390	275	294
	c)	1.12	0.16	0.92	0.72	0.82	1.05	0.89
Mg	a)	800	794	1100	1500	600	700	890
	d)	790	1020	1085	560	582	598	728
	c)	1.01	0.77	1.01	2.67	1.03	1.17	1.22
Al	a)	ND	ND	200	ND	ND	ND	125
	d)	ND	ND	260	120	142	110	90
	c)	-	-	0.76	-	-	-	1.38
a) = Ash Wt; d) = Dry Wt; C) = CAOB; ND = Not Detected								

Table.4 Elemental sequences of Backyard poultry

	Raw Eggs
Shell	a) Ba>Fe>Sr>Zn>Pb>Mg>Co>Cu>Ni>Mn>Cr,Al d) Ba>Fe>Sr>Mg>Cu>Pb>Co>Zn>Ni,Mn,Cr,Al
Edible part (yolk & albumen)	a) Ba>>Sr>Pb>Z>Mg> Cu> Co>Fe>Cr>Mn>Ni>Al d) Ba>Fe>Mg>Sr>Zn>Co>Pb>Cu>Ni,Mn,Cr,Al
Whole Egg	a) Ba>Fe>Sr>Zn>Pb>Mg> Cu> Co>Al>Mn>Ni>Cr d) Ba>Fe>Sr>Mg> Co> Cu>Pb>Zn>Al>Ni,Mn,Cr
CAOB of Raw Egg	
Shell	Mn>Zn>Co>Ni>Pb>Sr>Cu>Fe>Ba>Mg>Cr,Al
Edible Part (yolk & albumen)	Mn>Pb>Cu>Zn>Co>Sr>Ba>Mg>Ni>Fe>Cr,Al
Whole Egg	Mn>Zn>Pb>Cu>Co>Sr>Ba>Mg>Fe>Al>Ni,Cr
	Boiled Eggs
Shell	a) Mg>Ba>Sr>Pb>Fe>Zn>Co>Cu>Cr>Mn,Ni,Al d) Mg>Ba>Sr>Fe>Co>Cu>Zn>Cr>Al>Pb>Ni,Mn,Cr
Albumen	a)Ba>Co>Sr>Zn>Pb>Mg>Fe>Cu>Cr>Mn,Ni,Al d) Ba>Sr>Mg>Fe>Cu>Al>Pb>Zn>Co>Ni,Mn,Cr
Yolk	a) Ba>Sr>Co>Zn>Mg>Pb>Fe>Cu>Cr>Mn,Ni,Al d) Ba>Sr>Mg>Fe>Zn>Co>Pb>Al >Cu>Ni,Mn,Cr
Whole egg	a) Ba>Mg>Sr>Pb>Zn>Fe>Co>Al>Cu>Cr>Mn,Ni, d) Ba>Mg>Sr>Co>Zn>Fe>Pb>Al>Cu>Ni>Mn,Cr
CAOB of Raw Egg	
Shell	Mn,Cr>Pb>Mg>Ba>Zn>Co>Sr>Cu>Fe>Ni,Al
Albumen	Mn,Cr>Co>Zn>Pb>Sr>Ba>Mg>Fe>Cu>Ni,Al
Yolk	Mn,Cr>Pb>Co>Zn>Cu>Sr=Mg>Ba>Fe>Ni,Al
Whole Egg	Cr>Pb>Cu>Al>Mg>Ba>Sr>Fe>Zn>Co>Mn>Ni
a) = Ash Wt, d) = Dry Wt.	

5. Summary and conclusions

In the study area, wide variations in the physical properties of eggs may be attributed to their diet and conditions of their habitat. In Vemula barite mining area, the concentration of barium in the eggs of hen is remarkably higher on ash weight and dry weight bases. The eggs show maximum concentration of Ba followed Sr in Vemula barite area reflecting the ore element barium. The individual parts of raw and boiled egg samples show high concentration of Ba, Sr, and Pb on ash weight basis than dry weight basis. The elements like Ba, Sr, Pb, Zn and Cr in the study area show the concentration is high in edible part than in shell. Wide variations in the elemental sequences among the raw and boiled eggs on both ash weight and/or dry weight basis are observed In order to know the influence of organic matter in elemental distribution and behaviour, the egg samples were analyzed on both ash weight and dry weight bases and a biogeochemical parameter called coefficient of apparent organic binding (CAOB) is calculated. Wide variations are found in the CAOB values of the elements in different parts of the eggs. The CAOB for Ba is above unity in both the egg samples of barite area. High or low CAOB of a sample for an element mainly depends upon the influence of organic matter to bind or release the element into solutions or its capacity in varying the dissolution of the chemical elements to convert the element into an insoluble form.

The enrichment of Ba concentration in eggs of backyard poultry may be due to the presence of barium mineral and their surrounding habitat. This barite is responsible for the release of Ba predominantly in large amounts and the biogeochemical province (Vinogradov, 1964) is influenced by local enrichment of metals due to the existence of ore bodies and their associated dispersion halos. Further the biogeochemical data may be considered for the monitoring of the pollution levels of mining environment. Further, in the study area eggs consisting of high concentration of Ba and therefore backyard poultry eggs may ideally be used as tools for their possible application in barite mineral exploration. This study has given greater scope on the backyard poultry-soil relationship in the mining/mineralized areas and their significance in biogeochemical orientation surveys, nutrition status of an area and environmental studies.

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