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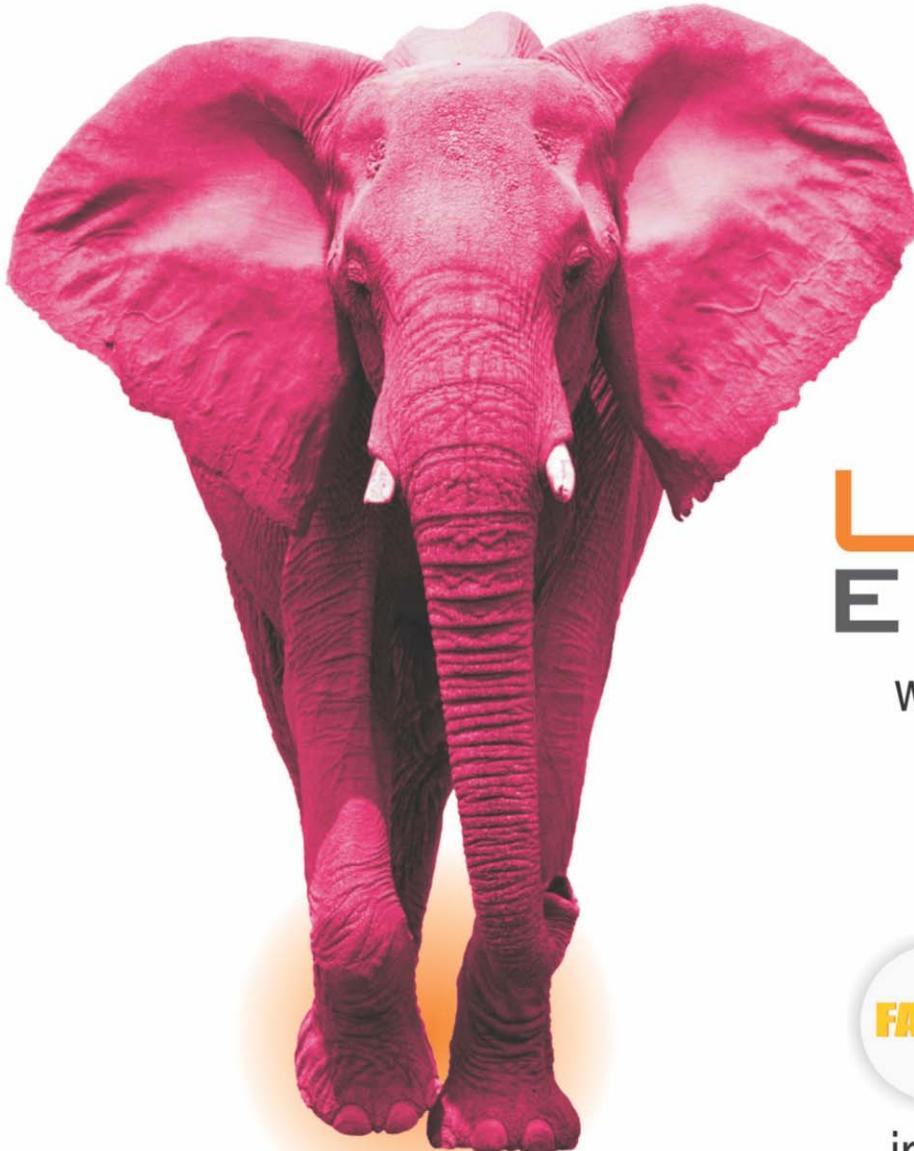
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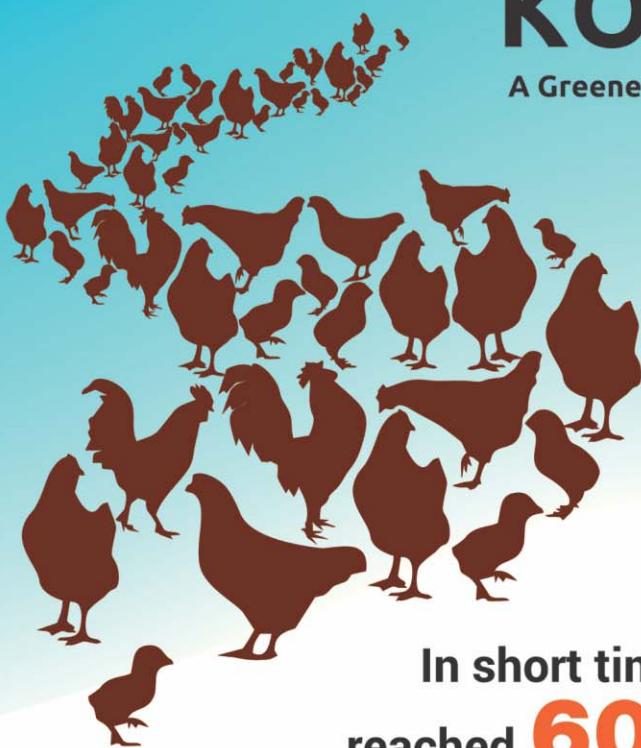


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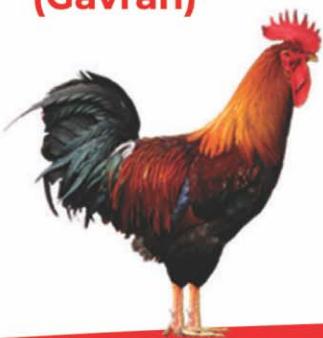


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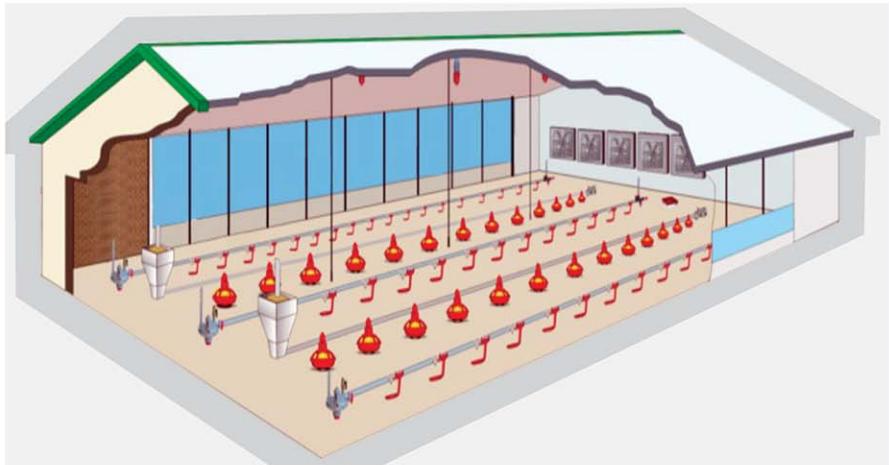
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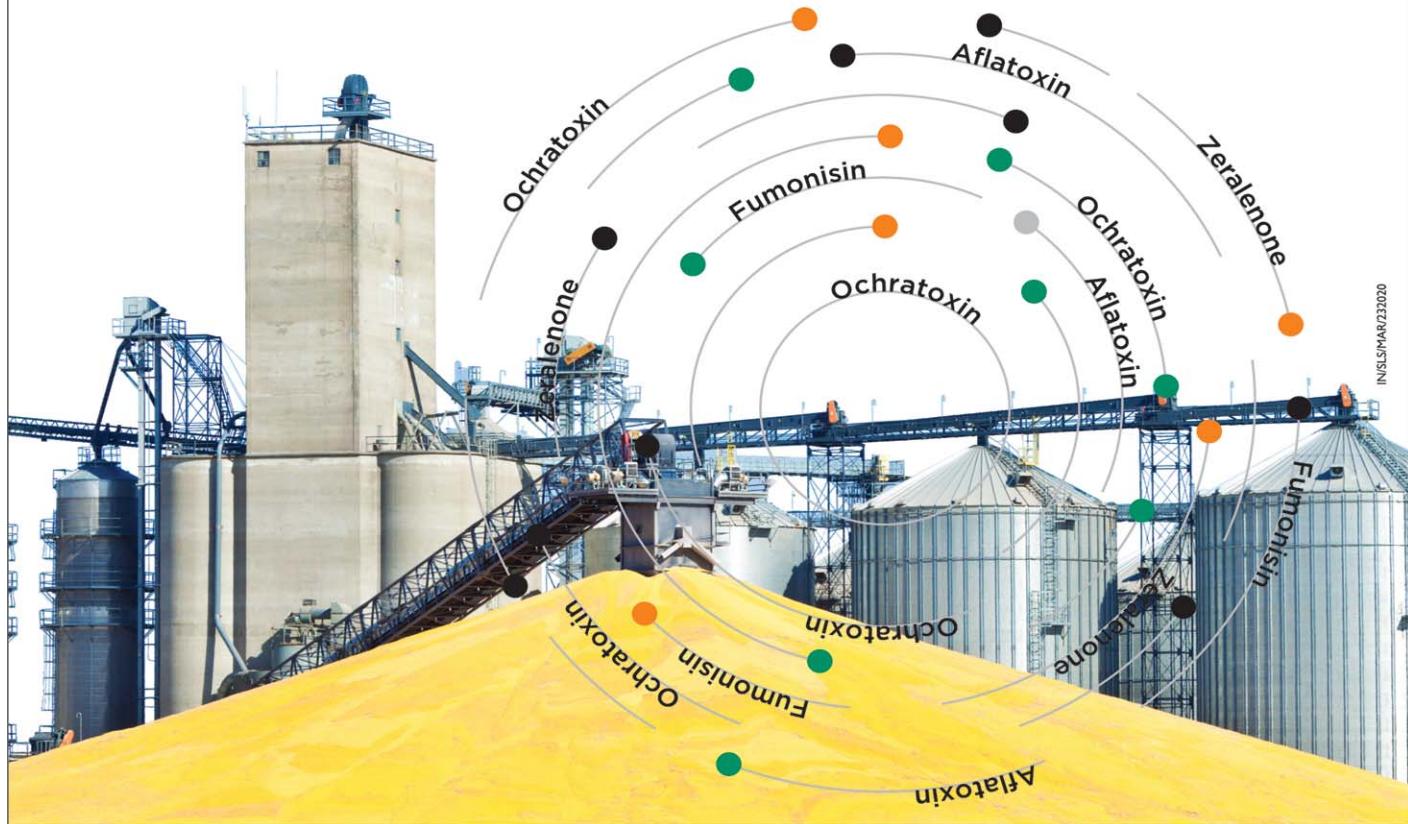
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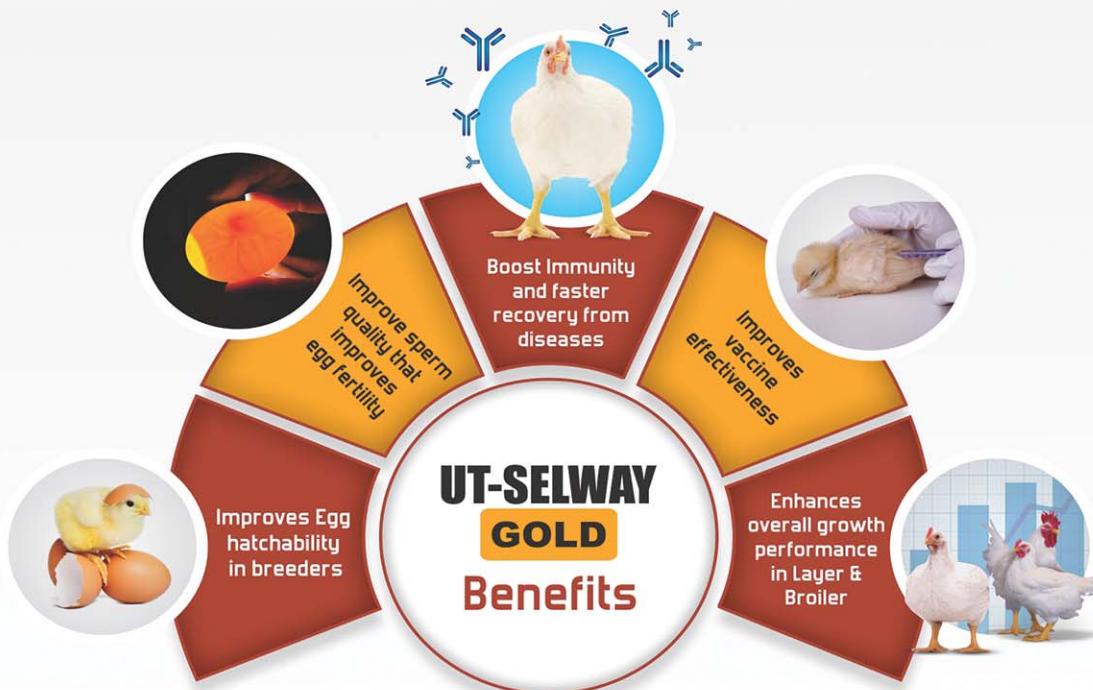
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Kadaknath: “Black Gold” - A unique nutritive source for better human health

Aakanksha Rathore¹, B. L. Saini²

¹Department of Animal Genetics & Breeding, College of Veterinary Science and Animal Husbandry, Chhattisgarh Kamdhenu Vishwavidyalaya, Durg, 495668, Chhattisgarh.

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Introduction: Kadaknath or “Kali Masi” is an indigenous poultry breed that inhabits in vast areas of Dantewada district of Chhattisgarh and Jhabua and Dhar districts of Madhya Pradesh. The bird is very common among Adivasis mainly due to its unique adaptability to the local environment, resistance to disease, tasty quality of meat, texture, and flavor. Though the flesh of this breed is black, it is considered not only a delicacy of distinctive taste, but also of medicinal value. Locally called Kalimasi — the fowl with black flesh — the Kadaknath is considered as a premium breed of poultry. Due to its high protein and very low fat and cholesterol levels, it is in high demand. Its fat content is 0.73 — 1.03% compared to 13 to 25% in most other chicken breeds. This famous kadaknath chicken from Jhabua District of Madhya Pradesh, India has now got a geographical indication (GI Tag) tag. It was approved by Indian government on 30 July 2018. The Kadaknath is popular for its adaptability and good-tasting greyish black meat, which is believed to infuse vigor. Its color stems from melanin. The breed is originated from the Indian state Madhya Pradesh. Kadaknath species are involved in commercial production due to higher nutritional value. Poultry industry is a significant source of income and employment to millions of people. The appearance colours of kadaknath are jet-black, penciled (Greyish) and golden plumage with a greenish iridescence colour, greyish black legs, toe and nails, greyish black beak and tongue, blackish comb and wattles, greyish black meat and bones and even dark organs. Colour completely depends upon weather conditions it may vary from greyish to complete black. The day-old chicks are brownish to black with irregular dark stripes over the back. The adult plumage varies from silver and gold spangled to bluish black without any spangling.

Most of the internal organs also show intense black coloration is also seen in skeleton muscle, tendons, nerves and blood. The black pigments are due to deposition of melanin. The roosters weigh 2–2.5 kg and the hens from 1.5–2 kg. The hens lay cream-colored eggs with a slight pink tint, although they are poor setters and rarely hatch their own brood. Eggs weigh an average of 45 g.

Kadaknath Farming from economic point of view:

Kadaknath is an important indigenous breed of poultry that is renowned for its delicious quality of meat. The original name of the breed is Kalamasi, meaning a fowl with black flesh, which, though not very appealing to the eye, is very tasty. It has an excellent power of heat tolerance and resistant to diseases in its natural habitat in free range conditions but is more susceptible to Marek’s disease under intensive rearing conditions. It can thrive well under free ranging conditions with little grain supplementation/kitchen waste and can be housed in cheap katcha houses. The breed has a natural instinct of broodiness, which makes it a natural incubator and hatcher, a desirable trait for the villagers. The bird is said to contain many kinds of amino acids and vitamins and are a powerful source of protein.



Fig: Kadaknath semi intensive rearing



Fig: Eggs of black god- Kadaknath

Three Breeds are available in Kadaknath Chicken in India, These are following:-

(1) Kadaknath Cross:

- Cross breed of kadaknath which is farming with other broiler grade country chicken breeds
- It has meat colour mixture of black, red and white
- Feed consumption is little high than daulat organic kadaknath and kadaknath pure line breeds
- 1-1.2 kg body weight at 3 - 3.5 months



(2) Kadaknath Pureline:

- Pure breed of Kadaknath Chicken is a little high feed Consumption than Daulat Organic Kadaknath Breed.

- It gains 1-1.2 kg body weight at 3.5 - 4.2 Months.
- It has blackish colour meat



(3) Daulat Organic Kadaknath:

- India's First Organic Kadaknath Breed with many special qualities
- Very Low Feed Consumption Low Maintenance,
- Original & Organic Breed, and No need of vaccinations
- 1-1.2 Kg body weight at 3.5 - 4.2 Months
- It has meat colour Black



Nutritive Value Of Kadaknath Products

Meat:

'Kadaknath' is known for its high iron content and much lower cholesterol than other breeds, and sells at a much higher price than other varieties. Some important features of kadaknath meat are:

- Protein content more than 25% which is highest among all chicken breeds
- Fat content is 0.73-1.05% only, which is lowest of among chicken breeds.
- The amount of fat deposited in the body of a kadaknath chicken is itself very negligible.
- Vitamins B1, B2, B6, B12, E, niacin and minerals are present in rich amount.

Nutritional comparison of kadaknath and other chicken breed has been shown in the below table:

No	Properties	Kadaknath	Other chicken breed
1	Protein content	25%	18 – 20%
2	Fat content	0.73 – 1.03%	13 – 25%
3	Linoleic acid	24%	21%
4	Cholesterol	184.75MG/100G	218.12MG/100G

- It contains very high levels of 18 essential amino acids that are required by the human body.
- It has great importance in siddha and homeopathy medicines for treating nervous disorder.

Egg:

The eggs are an ideal nutritive food, especially for old people and high blood pressure victims, since the cholesterol content is lower. Kadaknath eggs helps to meet the day to day protein requirement of growing children.

Medicinal properties of kadaknath meat

1. Source of Antioxidant

One of the health benefits provided by the Kadaknath chicken is to have antioxidant properties. As the consequence, it has antioxidant carnitine which has been shown in recent studies. Moreover, it is known that black chicken has more carnitine compared to the white chicken. Antioxidants have a big role in promoting the body health. Therefore, as black chicken can be your food option, then it will also help you to reduce the risks of certain health problems.

2. Improve the sexual performance and women health

Its meat has the property of aphrodisiac, which helps to increase the blood flow and improve the sexual performance. Experts say that Viagra or Sildenafil Citrate is basically a vasodilator designed for increasing blood flow and the melanin pigment in kadaknath does the same. It helps to promote the regular menstruation as well as promote the fertility. Indeed, these benefits are so valuable for women who want to have the healthy reproduction.

3. Protects Eyesight

Due to the presence of antioxidant properties in black chicken, it protects the eyesight.

4. High Protein more than 25% (Highest among the chicken breeds)

It is shown that black chicken has the higher amount of protein compared to other varieties of

other bird meat. This will be good for those who want to promote the body muscle, best for growing children. Indeed, protein has a role in promoting the building of body tissues as well. Not only for that, can protein foods help to stabilize blood sugar levels.

5. Low in Cholesterol (Low fat 0.73-1.05% (Lowest among the all chicken breeds)

Black chicken has the lower cholesterol level compared to the white chicken. This means very good as you can consume meats without having any worries of cholesterol foods. Therefore, if you want to start a healthy life but not so avoiding meat consumption, then black chicken should be added into your meal.

6. Promotes Heart Health: Due to the presence of iron and another kind of minerals in black chicken, then it is helpful to promote the heart health. As the iron and other minerals work together to prevent the blood clot, then it will cut the risks of heart problems. Moreover, it also helps to promote the blood circulation which will reduce the risks of heart attack and stroke as well.

7. Lower the headaches problem

The next health benefit provided by the black chicken is its ability to treat a headache. This one is linked with the benefits of its eggs. Then, the regular consumption of the eggs of black chicken can reduce the dizziness.

8. Lower the risk of asthma asthma:

Not only to treat a headache, can the eggs of black chicken be beneficial to treat asthma. Though this benefit still needs to be more proven but consuming black chicken can be the next step to have the healthier life.

9. Source of Iron: Kadaknath chicken meat has almost 10 times iron than any other chicken breed, is beneficial to prevent the risks of anaemia. It promotes the production of haemoglobin in the body. Not only for that, but iron also takes part in promoting the muscle formation.

10. Source of essential amino Acids

It contains higher levels of 18 essential amino acids that are required by the human Body. As a result, amino acids have been known as the muscle supplement. In this case, it promotes the muscle formation for sure. Moreover, it regulates the blood vessel flexibility.

11. Boosts Energy:

As described before, black chicken has the high amount of protein. This nutrient can be beneficial to boost the energy level in the body. Moreover, the presence of minerals and amino acids help to build the energy as well. Then, it is recommended to consume this kind of meat as you can have the energy booster to do daily activities for sure.

Egg and meat of Kadaknath is costlier:

A white leghorn hen is selectively bred to lay 320 – 330 eggs out of 365 days in a year, whereas a kadaknath hen lays around 120 -130 eggs in a year taking the same amount of feed as that of a white leghorn hen. So it's obvious that the price has to be 3 times higher as that of a white egg. A broiler chicken gains 2.5 kg of body weight in 40 -45 days. It almost inflates like a balloon day-by-day. Its gene has been selected so that its only work is to eat and get obese. Even if you don't kill a broiler chicken at 45 days of age it will die very soon due to obesity (under intensive rearing farm condition). Kadaknath being a desi bird involves a lot of physical activity and its weight gain is "slow and steady". A kadaknath cock attains body weight of 1.5KGS in 120 -130 days. It takes nearly thrice the time to attain half the body weight of a broiler chicken. If you don't kill it will live up to the age of 12 years reaching a maximum of around 2KGS body weight only. So our cost of production is nearly four times higher than that of a broiler chicken. That's the reason that many giant breeders did not turn to kadaknath even

through it's so useful to the mankind, all corporate in poultry field are concerned about quick profit only.

Weed controller activity:

It has been observed in Central Poultry Development Organization (CPDO) Chandigarh wherever the Kadaknath has been housed in Extensive system the weeds are under control means Kadaknath keeps entire area free from any weed. It keeps entire range free from weeds.

Perching habits and self-protection from predation

One of the excellent characters of Kadaknath is perching habits. It perches on bushes, lentils, tree tops and branches. This helps plenty of space saving and space utility. Kadaknath protects itself from any predator and perching habits also helps to avoid any predation loss by wild cat, mongoose, snakes and dogs which are natural predation of chicken.

Conclusion: On account of poor egg production and growth potential, as compared to the modern day commercial breeds, this breed is threatened due to the Government schemes which supply commercial chicks to the farmers on subsidized rates. A more organized approach towards marketing of products, including establishment of common selling points at strategic locations, by local entrepreneurs, would go a long way in creating a brand image for the birds (especially Kadaknath) from the area. The breed has certain distinct characteristics; it is a medium sized breed, so the management of the flock in terms of housing, feeding and health cover may be economical. It is a precious nature germplasm for the country which has generated hopes among rural and tribal people to improve supplementary income. This fowl is useful as backyard poultry in remote areas. The endangered unique germplasm of the country needs to be conserved for future exploitation.

As poultry industry is also a significant foreign exchange earner and a source of income and employment to millions of people. The eggs and meat of Kadaknath reared in the backyard farming will certainly improve economic status of a majority of rural/tribal families.

BROILER LIFTING RATES FOR THE MONTH OF NOVEMBER 2020

place	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Hyderabad	105	105	105	98	98	90	90	82	82	84	86	86	88	90	92	94	94	94	91	88	88	88	88	80	80	82	85	89	89		
Karimnagar	105	105	105	98	98	90	90	82	82	84	86	86	88	90	92	94	94	94	91	88	88	88	88	80	80	82	85	89	89		
Warangal	105	105	105	98	98	90	90	82	82	84	86	86	88	90	92	94	94	91	88	88	88	88	80	80	82	85	89	89			
Mahaboobnagar	105	105	105	98	98	90	90	82	82	84	86	86	88	90	92	94	94	91	88	88	88	88	80	80	82	85	89	89			
Kurnool	105	105	105	98	98	90	90	82	82	84	86	86	88	90	92	94	94	91	88	88	88	88	80	80	82	85	89	89			
Vizag	98	98	93	93	87	87	87	80	80	80	80	82	82	84	84	86	86	86	86	83	83	77	77	80	83	87	87	87			
Godavari	105	105	105	98	98	90	90	82	82	84	84	86	86	88	90	92	92	92	92	89	89	89	80	80	82	85	89	89			
Vijayawada	110	110	110	103	95	95	95	87	87	87	89	89	91	91	93	95	95	95	95	95	89	89	81	81	83	86	90	90			
Guntur	110	110	110	103	95	95	95	87	87	87	89	89	91	91	93	95	96	96	96	96	91	91	83	83	85	88	92	92			
Ongole	110	110	110	103	95	95	95	87	87	87	89	89	91	91	93	95	96	96	96	96	96	96	96	96	96	96	96	96			

NATIONAL EGG CO-ORDINATION COMMITTEE

DAILY / MONTHLY EGG PRICES DECLARED BY NECC AND PREVAILING PRICES AT VARIOUS PRODUCTION CENTRES (PC) AND CONSUMPTION CENTERS (CC) JANUARY 2021

Name Of Zone / Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Average			
	NECC Prices																																		
Ahmedabad	550	560	535	535	535	535	535	535	535	535	535	535	535	535	535	535	535	535	535	535	535	535	535	535	535	535	535	535	535	461.48					
Ajmer	545	545	511	520	520	500	470	450	350	405	405	405	405	405	405	405	405	405	405	405	405	405	405	405	405	405	405	405	405	433.67					
Banwala	558	558	535	535	535	535	512	470	430	405	405	405	405	405	405	405	405	405	405	405	405	405	405	405	405	405	405	405	405	447.19					
Bengaluru (CC)	510	520	520	520	505	505	490	475	450	425	400	400	400	400	400	405	410	420	430	435	435	435	420	405	385	385	385	390	395	437.58					
Brahmapur (OD)	520	526	526	526	526	500	450	450	390	390	390	390	390	390	390	396	414	431	440	443	443	443	431	431	401	401	413	426	428	431	447.77				
Chennai (CC)	520	520	530	530	530	510	510	485	485	460	420	420	420	420	420	435	440	440	440	440	440	440	425	405	390	390	390	390	395	448.55					
Chittoor	513	513	523	523	523	503	503	478	453	413	413	413	413	413	413	428	433	433	433	433	433	433	418	398	398	383	383	383	388	441.55					
Delhi (CC)	600	600	575	565	555	555	555	525	495	475	435	421	421	421	421	421	440	475	485	485	470	470	475	435	435	425	425	425	425	425	476.39				
E.Godavari	511	516	516	516	516	516	516	516	516	516	495	495	495	495	495	495	495	495	495	495	495	495	495	495	495	495	495	495	495	495	496.77				
Hyderabad	511	516	516	516	495	495	495	460	420	360	360	363	366	369	375	385	395	405	410	410	410	410	410	395	380	365	368	373	378	383	386	389	411.06		
Ludhiana	555	556	556	556	535	515	502	476	476	451	426	407	407	404	404	412	425	455	460	460	450	450	435	420	412	392	397	398	403	405	405	449.32			
Mumbai (CC)	545	560	565	565	545	545	545	545	545	510	470	470	470	470	470	470	470	475	475	475	475	475	475	475	475	475	475	475	475	475	475	475	469.93		
Muzaffarpur (CC)	604	605	571	571	571	562	552	533	500	486	452	448	448	452	452	452	476	500	510	510	505	505	505	486	476	452	443	452	452	457	457	496.81			
Mysuru	510	520	520	520	505	505	490	475	450	425	400	400	400	400	400	407	412	423	435	440	440	440	421	405	385	385	385	392	397	397	397	438.74			
Nagpur	520	550	550	525	505	495	495	470	420	390	400	410	415	420	420	430	455	440	420	430	455	455	455	420	410	390	390	390	420	420	420	-	442.33		
Namakkal	495	510	510	510	510	510	510	485	485	460	460	420	420	420	420	420	425	425	425	425	425	425	405	380	380	380	380	385	385	385	385	424.84			
Patna	598	590	557	557	557	548	543	524	500	467	452	438	438	452	448	448	476	505	510	510	500	500	486	471	452	452	452	452	457	457	492.26				
Pune	550	560	560	560	540	530	520	510	490	470	450	430	410	412	414	416	421	421	421	421	421	421	420	400	400	400	400	400	400	400	467.23				
Ranchi (CC)	605	605	581	576	571	571	562	533	524	514	476	476	476	476	476	476	476	495	505	510	510	505	505	500	476	467	467	467	462	462	462	507.84			
Vijayawada	521	526	526	526	526	526	526	505	460	460	390	390	390	390	390	395	410	426	436	441	441	441	441	426	396	406	416	421	424	427	446.77				
Vizag	511	516	516	516	516	516	516	516	516	485	485	450	450	450	450	450	430	430	430	430	430	430	430	432	432	432	432	432	425	425	427	451.35			
W.Godavari	511	516	516	516	516	516	516	495	495	450	450	380	380	380	380	380	385	400	416	426	431	431	431	416	416	386	386	396	406	411	414	417	436.77		
Warangal	513	518	518	497	497	497	497	462	422	362	362	362	365	368	371	377	387	397	407	412	412	397	382	367	367	370	375	380	385	388	391	413.06			
Prevailing Prices																																			
Allahabad (CC)	595	590	557	548	538	538	524	500	476	479	414	400	448	452	490	524	524	490	467	438	429	429	429	410	429	443	443	438	429	414	473				
Bhopal	555	555	555	515	505	485	485	425	375	370	370	380	405	410	415	425	435	435	435	435	435	435	435	395	365	355	385	385	405	405	-	431			
Hospet	475	485	485	485	485	470	470	455	440	415	365	365	365	365	365	370	375	385	395	400	400	400	400	385	370	350	350	350	350	360	360	402.58			
Indore (CC)	550	550	525	525	510	500	475	475	475	475	475	475	475	475	475	475	475	475	475	475	475	475	475	475	475	475	475	475	475	475	475	-	448.79		
Jabalpur	560	560	545	535	525	525	525	507	495	495	390	370	370	370	370	421	423	428	432	435	435	435	435	425	415	405	395	395	401	410	412	412	-	444.57	
Kanpur (CC)	581	581	581	552	552	533	490	443	443	419	419	419	419	419	419	419	429	443	443	443	443	443	443	443	443	443	443	443	443	443	443	443	443	454.61	
Kolkata (WB)	568	560	571	571	571	571	571	520	500	490	440	425	425	425	425	425	430	445	455	470	480	480	480	480	470	470	470	470	470	470	470	470	470	489.61	
Luknow (CC)	633	633	600	583	567	550	550	550	533	517	500	483	483	483	483	483	467	467	467	467	467	467	467	467	467	467	467	467	467	467	467	467	506.77		
Raipur	550	550	550	535	535	535	535	515	495	460	460	460	460	460	460	460	460	460	460	460	460	460	460	460	460	460	460	460	460	460	460	462.83			
Surat	560	570	570	540	540	540	540	510	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	469.03
Varanasi (CC)	600	600	583	567	557	550	550	533	500	483	467	467	467	467	467	467	467	467	467	467	467	467	467	467	467	467	467	467	467	467	467	467	467	467	469.58

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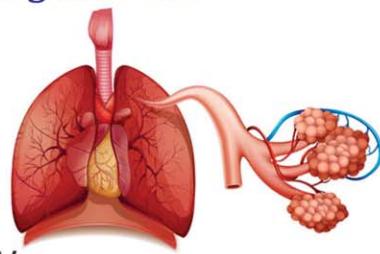
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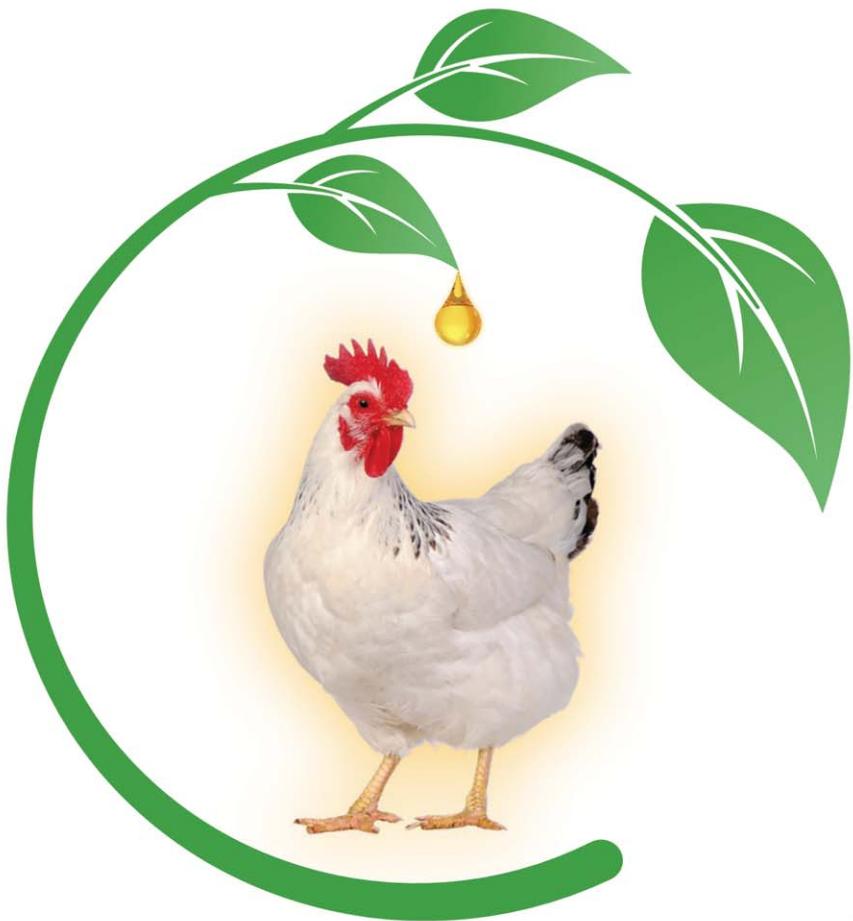
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Quail Farming: For Double the Income of Farmers

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Introduction: Quails are also called as *Bater* in Hindi. Quail farming business is economically very profitable. Quail farming in India is now recognized as an organized and scientifically based farming and a potential tool to fight with poverty and malnutrition. There is considerable scope for increasing the egg production further to meet the growing demand. The importance of quails in the poultry scenario of India is well recognized and quail production has registered a remarkable progress in the country since its introduction during mid seventies. Japanese quail farming offers a viable and practical solution to the problems of animal protein shortage and unemployment in developing countries. For small holders, it is an important source of income and employment generating venture besides providing nourishing food. Quail farming has been accepted by farmers as a potential alternative to chicken farming because of its small size, short incubation period, less floor space requirement, rapid growth, early onset of egg production, short generation interval, high rate of egg production, less susceptible to disease and low feed intake.

Quails are one of the most efficient biological machines for converting feed into animal of high biological value. At present in India, quails occupy the third largest position among poultry species next to the chicken and ducks. Quail meat is renowned for richness in vitamins, essential amino acids, unsaturated fatty acids, phospholipids and macro and micro elements. Cholesterol level is low as compared to chicken in quail egg and quail meat. Quail can adapt to varying environmental condition because of its hardy nature. Quail production requires less investment, gives quick return and



Suraj Amrutkar

higher profits and hence can be adapted by rural mass quickly. Incubation period of Japanese quail is 18 days. The Bob white quail is the second most important breeds of quail. Incubation period is 21 days. Quails were introduced in India in CARI in Izzatnagar in 1976 procuring hatching eggs from University of California.

Advantage of quail farming:

- Hardy in nature and do not require routine vaccination and medication.
- Attain faster growth rate and attain early sexual maturity; reach sexual maturity at 42 days/ bird of 6 weeks of age.
- High egg production rate 280-300 eggs/years. Japanese quail annual egg mass is 20 times than higher adult quail body weight but while in chicken 10 times. Egg weight to body weight: Quail 8%, Chicken 3% and Turkey 1%.
- Shortest generation interval: 3-4 generation per year. Thus making an important laboratory animal.
- It can adapt to varying environment condition because of similarity to chicken in many aspects. Quails are used as pilot animals in genetics, nutritional, physiologic, management and cancer studies.
- Quail used in embryonic research especially white shell line.
- Low feed requirements: Feed requirement 25 gm/day. Annual feed consumption 8kg/year. For broiler quails marketed at 5 weeks at 450 gm body weight.
- Shorter incubation period: 18 days

General characteristics:

Weight	Male: 130-150 gm Female: Female are heavier. (150-200gm) Weight of day old chick: 7 gm
Colour	Male: Upper part of breast is cinnamon coloured and lower part of breast is light brown colour Female: Face, throat and upper part of breast is light cinnamon with black stippings and lower part of breast having tan in colour. Sexes identified by 3 weeks of age with differentiate in plumage with 90-98%, precision approximately.
Voice	By 6 th weeks, male produce peculiar sound
Size	Males are smaller to female
Extra glands	Sexual active male have Cloacal gland or Foam gland

- Less floor space requirement: 8-10 Quails reared in place of 1 chicken.
- Medicinal value, used in Ayurvedic preparation; for T.B. treatment.
- Less fat, 20 more caloric value, more phospholipids and cholesterol, 16.2mg/g of yolk, chicken 17.9mg/g of yolk.
- Quail meat cholesterol is low 57.8 / 100gm of meat Vs. chicken 65.9mg / 100gm meat
- Quail meat promotes body and brain development in children.

Breeding of Quails for egg production:

Under the intensive system of rearing to get maximum fertility; optimum male: female ratio required. It was found that fertility was high with 1: 2-3 females. Artificial insemination has not been found to be useful for production of fertile egg due to low volume of semen and presence of foam during sperm production. There is seasonal effect on hatchability is observed during October to March month and poor hatchability is observed during June to August. Too many or too few quail cocks in the unit leads to higher proportion of infertile eggs. Quail cocks are aggressive when there are too many of them; a phenomenon called "Psychological castration" often arises as a result of peck order of

dominance pyramid. Cock at the base of the pyramid are usually not getting chance to mate by stronger males. As the phenomenon progress, despite the fact that, they are physically normal, weaker cocks will fail to mate even if they are separated and provided with hen. In the floor system of rearing, 1 male: 4-5 female is sufficient. Fertility of 80% or more is mentioned in Quail hens, even after the removal of males for 3 days. This is the shortest fertile for domesticated birds because chicken and ducks maintain fertility for 7-8 days and turkey 20 days after removal of males.

Age of breeding stocks:

Very young Quail cocks are often not sufficiently dominant to mate. In Japanese quail, maximum fertility is reached between 12-15 weeks of age, after which it declines gradually. In quail, body weight is a highly fertility trait. So for breeding purpose, selection is mainly by individual selection, mass selection. There is improvement of 2-5gm/generation, when the selection practiced for 4-5 week body weight. Individual selection for 4 week body weight is superior for improving performance.

Factor affecting fertility of eggs of Quail:

- Parents should be 10-20 weeks of age.
- Mating ratio is 1:2-3 in cages and 1:4-5 in litter system.

Space requirement:

Parameter	Starter (0-3 weeks)	Grower (4-6 weeks)	Layer
Floor space (In cage)	75 cm ²	110 cm ²	150 cm ²
Floor space (In deep litter)	75 cm ²	200 cm ²	250 cm ²
Feeder space (Linear space)	2 cm	2.5 cm	3 cm
Water space (Linear space)	1 cm	1.5 cm	2 cm

Quail Nutrition:

Nutrient	Starter (0-3 week)	Grower (4-5 weeks)	Layer (6 weeks onwards)
Energy (Kcal/bird)	2750	2750	2700
Protein %	27	24	22
Calcium %	0.8	0.6	3.0
Phosphorus %	0.3	0.3	0.45
Vitamin A (IU/Kg)	10000	10000	10000
Vitamin D (IU/Kg)	1250	1250	1250
Lysine %	1.4	1.25	0.73
Methionine %	0.41	0.36	0.32

To every 100 Kg add, Lysine: 50gm, Vitamin Mixture: 25 gm, Choline chloride: 50 gm, Methionine: 25 gm

- Egg should be collected for hatching after 4 days of introduction of male and female; and till 4 days after mating and separated.
- Breeders should be fed with Quail breeder ration.
- Beak should be slightly cut using debeaker to check cannibalism.
- Special care should be taken in debeaking of males.
- Fertility will be decrease when the male are more than 6 month old.
- Hatchability of fertile eggs reduces with the age of female.
- Ageing has no effect on fertility of male.
- Hatchability is maximum in eggs of 10-24 weeks of age.
- Hatchability is better in winter season as compared to summer and monsoon.

Physical and Chemical composition of Eggs:

Shape is spheroid, characterized by variety of colour from dark brown, blue and white, each heavily molted with black and brown. Egg shell pigments of quail egg are ooporphycin and biliverdin and blue green eggs have oocyan pigments. Peculiarity to shape, size, colour pattern are characteristic of individual quail layer. Weight of the quail egg is 10-12 gm.

Parameters	Quail egg	Chicken egg
Egg weight (gm)	10.3	56.7
Cholesterol content less in Quail	16.3 mg/gm yolk	17.94 mg/gm yolk
Moisture %	73	74
Protein %	13.23	12.8
Fat %	10.83	11.50
Ash %	1.03	1.0
Carbohydrate %	1.02	0.90
Energy (Kcal/100g egg)	158	156-183
Calcium (mg)	59	58.5
Phosphorus (mg)	220	181
Iron (mg)	3.8	2.4
Thiamine (mg)	0.12	0.08
Riboflavin (mg)	0.85	0.30
Niacin (mg)	0.10	0.07
Vitamin A (I.U.)	300	370

Constraint and strategies for Quail farming:

Though the nutritional and managemental requirements have been standardized, the aspect of parental mating ratio has not been investigated in details. Too many or too few quail males in the unit could lead to a higher proportion of infertile eggs. Quails male are aggressive and when there are too many of them, a phenomenon called Psychological castration often arises as a result of forming a peak order or dominance. Cocks at the base of the pyramid are usually knocked about and prevented from mating by the stronger, more dominant males. As phenomenon progress, despites the facts that they are physiological normal, the cocks will fail to mate even if they are separated and given hen for their own. On the other hand, placing too few cocks in the unit will result in omission of some hens from being mated.

Behavior problem:

Cannibalism:

Cannibalism having in different forms: vent pecking, feather pecking, head pecking and nose pecking. Nose pecking is most common type of cannibalism

seen in birds of 2-7 weeks of age. Cannibal birds peck at the top of the mouth, where fleshy portion merge out with the beak where birds die due to blood loss. Even if the birds survive, beak permanently deformed and males not used for breeding purpose.

Reason: Insufficient Feeder'spaces and waterers space, underfeeding, insufficient nest space, over crowing, mineral deficiency, especially sodium and chloride. Excess maize in the diet, pellet feeding, strong artificial light, high amount of temperature, irritation from external parasite.

Prevention: Debeaking is practical suggestion. Papaya or green leaves hang in the cages. Azolla and Tulasi leaves can be given to the quail bird.

Health Status of Quail

Bacterial diseases:

Ulcerative Enteritis (Quails disease):

It is caused by *clostridium colinum* which affects quail of all ages. Young birds are more susceptible than older birds. Mortality is 5-10%. It is common in quails reared on floor, spread rapidly through droppings.

Symptoms: Healthy birds exhibit white watery droppings, birds becomes listless, dull with ruffled feather.

P. M. lesions: Yellowish button like ulcers on intestine and ceca. Necropsy of spleen and hemorrhages on spleen.

Treatment: Antibiotic reduces mortality. Streptomycin: 1gm/1 litre water, Enrofloxacin: 1gm/1 litre of water for 3 days effectively control the disease.

No Vaccination: Only preventive measures are observed to be of significance. Common preventive disease control measures are more or less similar to chicken like preventing dust, cleaning of waterers and feeders, buying chicks from disease free stock, rear in stress free condition since quails are highly excitable. When disturbed, they fly upward and injure head, reared different age group birds separately, isolate weak birds, destroy dead birds.

Avian cholera/ Avian Pasteurellosis:

Affecting domesticated and wild quails. It causes high mortality. It is caused by *Pasteurella multocida* which produce enterotoxin which leads to septicemia. It is normally transmitted through introduction of new birds to older population. Wild birds act as carriers.

Symptoms: Acute stage: mortality. In less severe attack, symptoms are fever, anorexia, mucus discharge from mouth, diarrhea and increased respiratory rate, several materials associated with diarrhea which initially watery and whitish and later becomes greenish in colour and contain mucus. Mortality is high as 90-100%. In chronic cases, symptoms are blue sinuses, swelling of legs and long joints and sternal bursa.

Treatment: High level of antibiotics.

Pullorum disease:

It is caused by *Salmonella Pullorum*.

Symptoms: If the birds are hatched from infected eggs, dead birds found in incubator or within 5-10 days of hatching, it dies. In chicks, mortality occurs in 2nd and 3rd week of hatching, droppiness, ruffled feathers, huddling, whitish diarrhea, laboured breath, gasping.

P.M.: It does not manifest any characteristic symptoms.

Treatment: Remove carrier birds. Remove the flock itself. Antibiotic can reduce mortality. Recover bird's acts as a carrier birds, so not used for breeding purpose.

Viral Diseases:

New castle disease: (*Paramyxo virus*)

Over 100 strains and species, so the wild birds are acts as carriers. Pigeon and quails are resistant to certain strains of the disease. Disease may be mild when the symptoms are scarcely noticed or absent. But due to some other strains, disease occurs severely. Incubation period of disease is 2-3 days after infection with an average of 5-6 days. Incubation time of disease and severity of disease decrease gradually from hatching to maturity in young birds are more susceptible. In outbreak of new castle diseases may be so acute and severe to kill all the birds in a flock within 4 days. Symptoms vary depending on strains of the virus.

Symptoms: Birds first appear listless, gasping, coughing, difficulty in breathing within 3-4 days. There may be oedema in tissue around the eyes and throat, greenish diarrhea, spasms, muscular tremors and paralysis of legs and wings are commonly seen. Mortality in adult is 50% and in chicks 90%.

Quail bronchitis:

Respiratory disease common in Bob white quail. Other species are resistant. It is caused by virus.

Symptoms: Tracheal rails, sneezing and coughing, nasal discharge, incubation period varies from 4-7 days.

Treatment: No specific treatment. Antibiotic is helpful to prevent secondary infection.

Corona viral disease:

Newly discovered virus, which affects quails of all ages. This virus affects only intestinal tract. Incubation period is 3-5 days.

Symptoms: subnormal body temperature, anorexia, weight loss, frothy watery discharge, drops in feed

and water intake, drop in egg production, choky white egg shell. Recovered birds are immune but acts as carriers.

Treatment: No treatment to prevent outbreak. No vaccination.

Nutritional deficiency diseases:

Vitamin A: Essential for growth, vision and integrity of mucous membrane.

Symptoms: when adult quail are fed with diet deficient vitamin A., symptoms develop in 2-3 month only. Birds become weak, ruffled feather, decrease in egg production and hatchability, decrease in feed and water intake, sticky white substance accumulation in eye, watery nasal discharge.

Treatment: Vitamin A @ 12000IU/Kg diets. Birds are not responding to treatment very well at advance stage.

Vitamin D: It is needed for proper metabolism of Ca and P to form normal skeleton, hard beaks and strong egg shell. Stimulate absorption of Ca in gastro intestinal tract. Although vitamin D is produced in skin, it is not adequate for quails reared under intensive system.

Symptoms: Increase in number of thin and soft shelled egg followed by drop in egg production and hatchability. Extreme leg weakness followed by penguin like posture seen in feet. Later beaks and keel bone becomes very soft and pliable. Feather is poor in young chicks. Retarded growth, rickets. Soft and pliable beak. Chicks walk with great difficulty swaying from side to side.

Treatment: single dose of 10000 IU Vitamin D₃ / kg feed.

Riboflavin deficiency: Riboflavin are the active part of over a dozen enzyme system in the body, most of which associated with oxidation reduction reaction is involved in cell respiration.

Symptoms: Slow growth of quails because weak and emaciated, diarrhea within 2nd week, curled toe paralysis, dropping of wings, layer quails decrease in egg production, increased embryonic mortality, increase in size and fat content of liver, hatchability decrease within 2nd week of feeding riboflavin deficient diet.

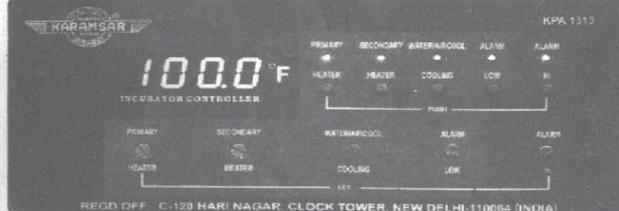
Manganese deficiency: Perosis is characterized by gross enlargement of knee joint and twisting of tibia. No treatment. Correct of mineral mixture.



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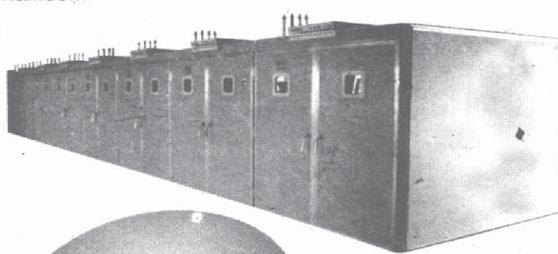
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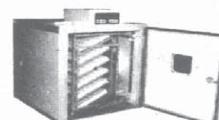
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Importance of micronutrients supplements in poultry feeding

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Introduction: Feeding constitutes the fundamental and major management concern in poultry production since major expenditure (60-70%) is feed cost. Efficiency in feeding therefore is one of the key factors for successful poultry production. Micronutrients are the essential nutrients that cannot be synthesized in the body and poultry requires it in small quantities to perform various vital physiological functions in the body. Even though their dietary requirements are minor, they play a major role in the body metabolism, enzyme system, various physiological functions,

reproduction and growth. Vitamins and minerals are very important components of poultry diet and their deficiencies can produce numerous health problems including in some cases death. Thus, to prevent nutritional deficiencies and for optimal growth and production feeding a balanced poultry diet with the required micronutrients (vitamins and minerals) should be practised.

Micronutrients required in poultry

Different vitamins and minerals essential for poultry along with their functions and deficiency symptoms are as follows:

Micronutrients	Functions	Deficiency symptoms
Vitamin A	Vision, egg production, growth, epithelial and mucous tissue health	Decreased growth rate, egg production and disease resistance; ataxia, chronic respiratory disease; pinhead size yellowish white, round, cheesy patches in the mouth and throat
Vitamin D ₃	Mineral metabolism, bone and egg shell strength	Thin egg shells, bowed legs, decreased egg production and growth rate, rickets, ruffled feathers
Vitamin E	Immunity, reproduction, antioxidant	Muscle weakness, decreased fertility, encephalomalacia, exudative diastasis, enlarged hocks
Vitamin K	Blood-coagulation, bleeding	Hemorrhage, blood spots in eggs
Vitamin C	Better immunity, heat tolerance, anti-oxidant, alleviates stress	Decreased immunity, more mortality due to heat strokes and stress
Vitamin B ₁ (Thiamine)	Intermediate metabolism, appetite, health of nerves	Polyneuritis, anorexia, weakness particularly of the legs, weight loss, in-coordination and jerky movements of the neck and legs.
Vitamin B ₂ (Riboflavin)	Cell-respiration, embryonic-growth, hatchability	Curled toe paralysis, decreased hatchability, poor growth, poor egg production
Niacin	Coenzyme-NAD, carbohydrate metabolism	Slipped tendon disease, black tongue, decreased growth, bowed legs, inflammation of tongue and mouth cavity
Vitamin B ₅ (Pantothenic Acid)	Coenzyme-A, growth and skin health	Dermatitis at corners of eye, mouth and feet, decreased hatchability and egg production, sitting back on hocks and unwillingness to move

Pyridoxine	Protein-metabolism, growth, nervous health, coenzyme	Anorexia, decreased growth, perosis, convulsions
Biotin	Metabolism, growth, hatchability	Perosis, decreased hatchability, dermatitis at corners of eye, beak, feet
Folic acid	Metabolism, growth, feather development	Anaemia, decreased growth, late embryonic mortality, poor feathering, egg production
Vitamin B ₁₂	Cofactor, growth nerve health, hatchability	Decreased growth and hatchability, nervous symptoms, perosis, anaemia
Inositol	Metabolism, growth, liver function	Anaemia, fatty liver, decreased growth
Choline	Coenzyme, lipotropic agent	Perosis, fatty liver, decreased growth and egg production
Manganese	Organic matrix for bone and shell, part of several enzymes	Perosis, chondrodystrophy, star gazing posture, decreased egg shell quality, egg production and hatchability, reduced growth and feather development
Zinc	Carbonic anhydrase and other enzymes, immunity, hormone production	Retarded growth, poor and frizzled feathers, impaired skeletal development, shortening and thickening of leg bones and enlargement of the hock joint, scaling of the skin, loss of appetite, reduced egg production, chicks hatched are weak, cannot stand, eat or drink, have accelerated respiratory rates and labored breathing, embryos exhibit micromyelia, curvature of the spine, and shortened, fused thoracic and lumbar vertebrae, toes often are missing and in extreme cases, no lower skeleton or limbs. Some embryos are rumples and occasionally the eyes are absent or not developed
Iron	Prosthetic group for many enzymes, RBC formation, uric acid synthesis	Anaemia, depigmentation of feather, mid embryonic mortality
Copper	Coenzyme-A, RBC formation	Anaemia, spastic paralysis, early embryonic mortality, ataxia, fragile bones, thickened epiphyseal cartilage
Iodine	Thyroxine production, controls BMR, thermoregulation	Goitre, decreased egg production, growth, hatchability; delayed yolk sac absorption, obesity, long and lacy feathers
Selenium	Immunity, spares vitamin E, constitutes glutathione peroxidise, antioxidant	Muscular dystrophy, exudative diathesis, immunodeficiency, pancreatic dystrophy, edema in the inner surface of thighs and wings, birds bruise easily and large scabs formed on old bruises, decreased egg production, hatchability and feed conversion
Molybdenum	Cofactor for Xanthine oxidase, DNA and RNA synthesis	Decreased growth rate
Chromium	Glucose tolerance, anti-oxidant, hypocholesteremic	Decreased growth and egg quality, immunosuppressant
Cobalt	Part of vitamin B ₁₂	Decreased growth and hatchability

Magnesium		Slow growth, panting and gasping, brief convulsions, rapid decline in egg production, decreased egg size and shell weight
Sodium	Acid-base balance, osmo-regulation	Decreased cardiac output, blood pressure and elasticity of subcutaneous tissues; retarded growth, soft bones, corneal keratinization, impaired food utilization, reduced egg production, cannibalism, impaired adrenal function
Potassium	Acid-base balance, osmo-regulation	Overall muscle weakness including cardiac weakness, and failure of respiratory muscles.
Chloride	Acid-base balance, osmo-regulation	Ataxia

Recently identified active principles (new generation micronutrients) which improve the overall health and performance of poultry are:

Active principles	Effect in poultry
Sialic acid	Antimicrobial, anti-inflammatory, antivirulent, performance enhancer
Lecithin	Conjugates with vitamin B ₁₂ , emulsifier, helps in fat digestion
Phosvitin	Anti-oxidant
Carotenoids, Lumiflavin, Lumichrome	Anti-oxidant, anti-carcinogenic, improves yolk and skin pigmentation
Lysozyme	Antimicrobial
Intralipid (Amphotericm B lipid)	Carrier for fat soluble vitamins and drugs, better feed conversion ratio
Sulphoraphane	Anti-carcinogenic
Taurine	Retinal tonic, prevents atherosclerotic plaque formation
Betaine	Methyl donor, prevents atherosclerotic plaque formation and diarrhoea
Eugenol, Eugenic acid	Immunomodulator
Lutein	Antioxidant and retinal tonic
Lycopene, Nirangenin, Tocotrienols	Lowers bad cholesterol (LDL)
Phytosterols- statin	Increases good cholesterol (HDL)
Quercetin, Luteolin, Diosgenin, Citogen	Stimulates insulin secretion and prevents diabetes
Gamma oryzanol	Increases HDL and anti-oxidant

Micronutrients requirement in poultry (/kg feed):

Micronutrients	Layer				Broiler		
	0-6 weeks	6-12 weeks	12-18 weeks	18 weeks - 1 st egg	0-3 weeks	3-6 weeks	6-8 weeks
Vitamin A (IU)	1500	1500	1500	1500	1500	1500	1500
Vitamin D3 (IU)	200	200	200	300	200	200	200
Vitamin E (IU)	10	5	5	5	10	10	10
Vitamin K (mg)	0.5	0.5	0.5	0.5	0.5	0.5	0.5

Vitamin B1 (mg)	1	1	0.8	0.8	1.8	1.8	1.8
Vitamin B2 (mg)	3.6	1.8	1.8	2.2	3.6	3.6	3.6
Vitamin B5 (mg)	3	3	3	3	3.5	3.5	3
Vitamin B12 (mg)	9	3	3	4	10	10	7
Niacin (mg)	27	11	11	11	35	30	25
Pantothenic acid (mg)	10	10	10	10	10	10	10
Folic acid (mg)	0.55	0.25	0.25	0.25	0.55	0.55	0.50
Biotin (mg)	0.15	0.1	0.1	0.1	0.15	0.15	0.12
Choline (mg)	1300	900	500	500	1300	1000	750
Manganese (mg)	60	30	30	30	60	60	60
Magnesium (mg)	600	500	400	400	500	500	500
Zinc (mg)	40	35	35	35	40	40	40
Iron (mg)	80	60	60	60	80	80	80
Copper (mg)	5	4	4	4	8	8	8
Iodine (mg)	0.35	0.35	0.35	0.30	0.35	0.35	0.35
Selenium (mg)	0.15	0.15	0.15	0.10	0.15	0.15	0.15
Cobalt (mg)	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Chromium (mg)	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Molybdenum (mg)	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Sodium (%)	0.15	0.15	0.15	0.15	0.16	0.16	0.16
Chloride (%)	0.15	0.12	0.12	0.15	0.16	0.16	0.16

*Some of the commercially available feed supplements for poultry are Provital, Growvit Power, Grow B-Plex, Stress Chek, Poultry All In One Formula, Chelated Growmin Forte, etc.

Conclusion

Vitamins and minerals nutrition is considered important not only for preventing deficiency signs but also for optimising health, productivity and product quality. Micronutrient requirement by poultry depends on the age, gender, reproductive state, ambient temperature and production aims. Inclusion and utilization of traditional feed ingredients for nutritional evaluation of more locally grown and novel indigenous crop sources offers increasing availability of relatively cheaply

manufactured synthetic forms. Greater accuracy in dietary macronutrient and micronutrient provision not only results in enhanced bird performance characteristics, but also reduces the likelihood of nutrient waste posing a pollution threat to the environment, which will be an increasingly important issue in the future. Manipulation of voluntary feed intake (VFI) in birds is the key to the control nutrient intake levels, and therefore ultimate performance and productivity. The factors influencing VFI will merit further scientific and commercial evaluation in the future, particularly with the prospect of climate change and the effect of elevated temperatures and other climatic variables on appetite.

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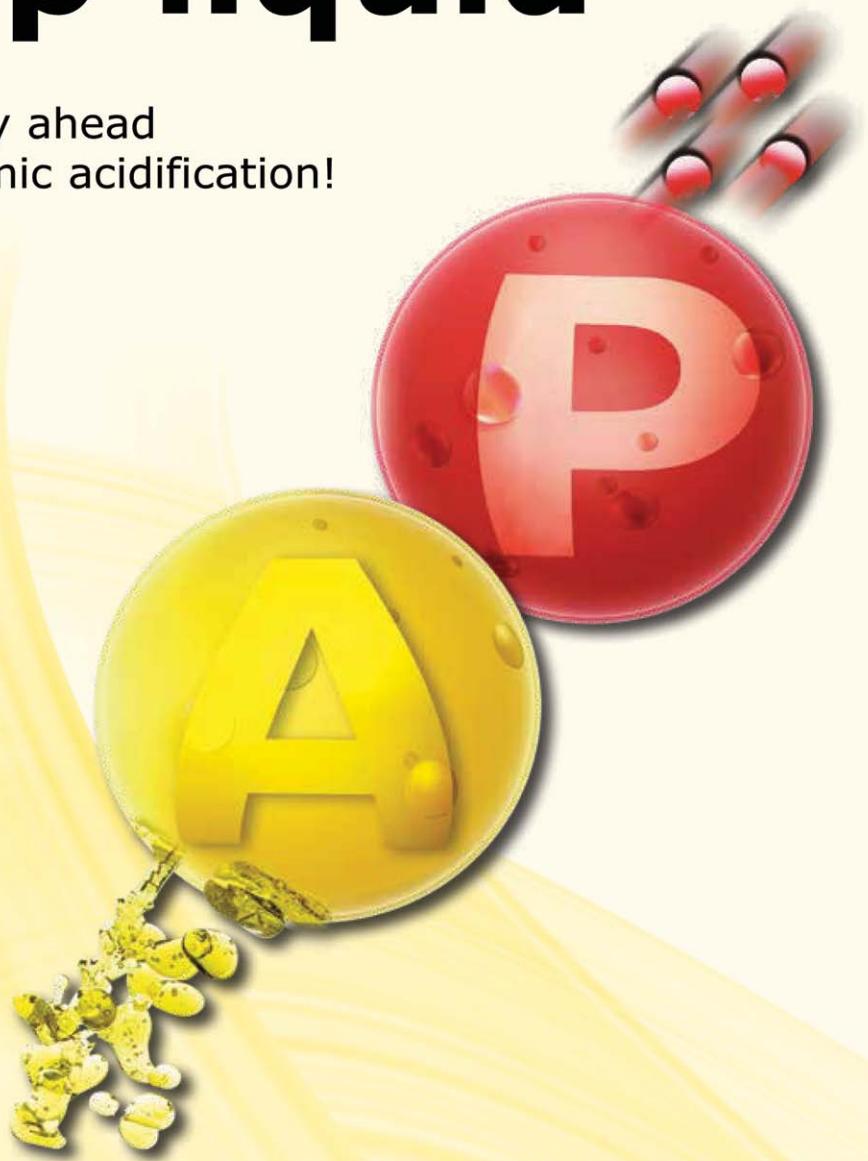
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Wet Droppings or Diarrhea

Wet droppings or chicken diarrhea are an early warning sign of intestinal distress that can provide a producer an invaluable insight into the overall gut health of their birds.

The normal intestinal transit time of commercial poultry is fairly fast, only about 4-8 hours, thus serious situations can arise very quickly. Moreover, wet litter is associated with numerous concerns including animal welfare issues such as contact or footpad dermatitis and reduced air quality due to increased ammonia concentrations. (Read [5 tips to successfully manage poultry house ammonia levels](#)).

Wet litter could also present a food safety concern as it provides an ideal environment for bacterial growth.

Diarrhea can often be a complex issue as it can be caused by a variety of means including both non-pathogenic and pathogenic agents. Due diligence on behalf of the producer is necessary to identify the underlying cause of the disturbance and take

corrective actions as soon as possible in order to return to optimal gut health.

Management Causes

Excessive water intake has a direct correlation with the incidence of wet droppings. High temperatures and humidity within the house can lead to heat stress in birds and cause them to drink more and eat less in attempts to regulate their body temperature. Moreover, heat stress has been shown to impair intestinal integrity and lead to a leaky and inflamed gut. Compromised gut integrity will reduce net water absorption from the intestinal tract, thus resulting in watery excreta; alternatively, excess nutrients will increase renal outputs of water.

Nutritional Causes

High intake of the minerals potassium, magnesium, sodium, sulfate, or chloride through the feed or water can cause increased water consumption as birds try to maintain their electrolyte balance, thus leading to wet droppings. Feed levels of salt should be evaluated to insure that a mixing error has not occurred and mineral concentrations in the water should be tested regularly. Poor quality or rancid fat can also lead to diarrhea. Additionally, certain feed ingredients, particularly those high in Non-Starch Polysaccharides (NSP) such as wheat, barley, and rye, are often associated with incidence of wetter and more viscous excreta as these components trap water and prevent it from being reabsorbed. For diets high in these feed ingredients, it is common practice to use commercially available NSP-degrading enzyme preparations.



Mycotoxins

Moldy feed or feed ingredients can also be a source of mycotoxins. Mycotoxins – toxic fungal metabolites produced by common molds found in many components of poultry diets— can directly reduce gut integrity, thus leading to decreased absorption and digestion of dietary nutrients and increased intestinal barrier permeability, which in turn can lead to wet litter. Furthermore, some mycotoxins, like ochratoxins, can cause damage to the kidneys and lead to increased diuresis.



Source: Sebastian Kaulitzki

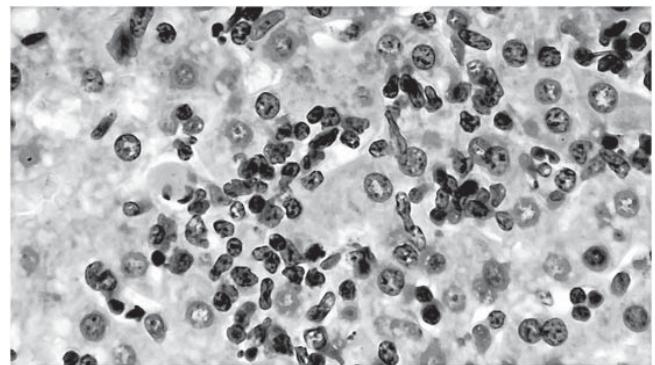
Pathogenic Causes

Coccidiosis, caused by protozoan parasites of the genus *Eimeria*, is the most frequently cited disease associated with increased incidence of diarrhea. Coccidial infection, resulting either from natural disease outbreak or from introduction at low levels through live coccidiosis vaccination, can damage the intestinal epithelium, allowing the leakage into the intestinal lumen. Moreover, the leakage of plasma proteins can provide a rich nutrient substrate that *Clostridium perfringens* can exploit for proliferation and toxin production, hence leading to necrotic enteritis.

Bacterial diarrhea or dysbacteriosis, a non-specific bacterial enteritis, is another highly cited cause of

wet excreta. Dysbacteriosis is an imbalance of the intestinal microbiota caused by several non-infectious and infectious factors such as high inclusion of NSP in the diet, coccidia, and *C. perfringens*. Dysbacteriosis may also be a result of an abrupt change in feed or other stress factors, which upset the usual microbial balance in the intestine.

Pathogenic bacteria, like *Escherichia coli*, *Campylobacter jejuni*, and *spirochaetes*, as well as several viruses, such as adenovirus, coronavirus, reovirus and rotavirus are known to have been implicated as a causative agent of diarrhea.



Conclusion

Diarrhea is a common occurrence in the poultry industry that can provide valuable insight into the overall health of the bird.

Wet droppings are a sign that the gut is not able to work at full efficiency and feed conversion and thus profits are not where they could be. Determining the underlying cause of wet droppings can often be multi-factorial and complicated, but uncovering these issues and implementing a targeted mitigation strategy will foster a quick return to optimal gut health, which will ultimately pay dividends in the long run.



Novus partners with biotech innovator Agrivida to bring new feed additive technology to the market

SAINT CHARLES, MO (January 13, 2021) – In 2020, Novus International, Inc., a global leader in nutrition and health solutions for the animal agriculture industry, announced plans to redefine its business through an enhanced focus on gut health and innovation. The Missouri-based company is making good on its strategy with a new partnership.

“Novus and its Board of Directors are very excited to announce the partnership with Agrivida,” said Novus CEO and President Dan Meagher. “Agrivida’s novel and innovative technology allows for the delivery of feed additives in a completely unique and very sustainable way – directly inside of the grain. It is technology like this that will further show Novus’s commitment to our customers: to help them produce wholesome, affordable food in an efficient and sustainable way.”

Agrivida, a privately held biotechnology company based in Massachusetts, was founded in 2003 by scientists from MIT who discovered a way to incorporate feed additives directly into corn grown for production animals. By having the additive inside of the grain, the molecules are more efficiently absorbed, and producers can improve both animal performance and their bottom line.

The partnership combines Novus’s nearly 30 years of research, sales and marketing experience with Agrivida’s unique technology, allowing both companies to grow the customer base as well as explore new innovative products and solutions through R&D collaboration.

Rajiv Singh, CEO of Agrivida, echoed Meagher’s enthusiasm about the partnership: “The Agrivida team has been undertaking groundbreaking work in biotechnology innovations to express functional proteins in grain. That work has led to the development of a sustainable production platform with application potential for many types of feed additives, and we are thrilled to partner with Novus, an organization that shares our commitment to

improving the world of animal health and nutrition through new technologies.”

Meagher adds, “We believe our customers value innovative, sustainable solutions to their challenges that also improve their cost position, and they will be eager to integrate a novel technology that delivers these advantages. We look forward to bringing this technology to customers and having them join us on the journey to continue transforming our industry.”

Novus is making Agrivida products available to its customers in the U.S. immediately while registration is underway to expand to other countries.

For more information on Novus visit www.novusint.com. For more information on Agrivida visit www.agrividacom.

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Novus International, Inc. is a leader in scientifically developing, manufacturing and commercializing animal health and nutrition solutions for the agriculture industry. Novus’s portfolio includes ALIMET® and MHA® feed supplements, MINTREX® chelated trace minerals, CIBENZA® enzyme feed additives, NEXT ENHANCE® feed additive, ACTIVATE® nutritional feed acid, and other specialty ingredients. Novus is privately owned by Mitsui & Co., Ltd. and Nippon Soda Co., Ltd. Headquartered in Saint Charles, Missouri, U.S.A., Novus serves customers around the world. For more information, visit www.novusint.com.

About Agrivida

Imagine it. Deliver it. Committed to building a better future for everyone, Agrivida scientists are experts in biochemistry, plant biology, molecular biology, agriculture, and nutrition. Dynamically addressing the needs of both animal nutrition and animal health through its unique technology platform, Agrivida is delivering on its promise of innovative corn products that offer effective, simple, and convenient solutions more sustainably than ever before. For more information, visit www.agrividacom.

Bacteriophages – History and Evaluation

Dr Ramdas Kambale, Senior Vice President, Vetrphage pharmaceuticals Pvt Ltd

Bacteriophages also known as "phages" are viruses that are capable of infecting bacteria. Phage comes from the Greek word *phagein* that means "to devour", so bacteriophage literally means "bacteria eater". Although it may seem odd that a virus can infect bacteria (single celled microbe) but in fact, bacteriophages are nearly 40 times smaller compared to bacteria. The bacteriophages get attached to their targeted bacteria via specific tail fibre receptors. The tail fibres happen to be one of the crucial structural elements of bacteriophages that makes each phage type specific to its host bacteria.

History

In 1896, a British bacteriologist named Ernest H Hankin observed that the waters from Yamuna and Ganga contained some biological principle which destroyed cholera-inducing bacteria. He also observed that millipore filters that were known to retain microorganisms like bacteria, couldn't stop this substance from passing through. In 1915, another British bacteriologist named Frederick Twort discovered a small agent capable of infecting and killing a bacteria.

Two years after the discovery made by Twort, Felix d'Herelle, a French-Canadian microbiologist observed a similar finding while studying patients recovering or suffering from bacillary dysentery. It was in fact d'Herelle who started bacteriophages use in clinical medicine and brought to light the "phage therapy" concept.

After the invention of the electron microscope, a German doctor named Helmut Ruska came up with the first physical description of the bacteriophages. Following his observations, Luria and Anderson visualised various types of bacteriophages and



Dr Ramdas Kambale

described their common structure. In the subsequent years, considerable progress was made in the field of bacteriophages with the first human experiments starting in the 2000s.

Bacteriophage Lifecycle

Similar to other viruses, bacteriophages need to infect their targeted bacteria to reproduce. The infection process involves a series

of steps which can be referred to as the 'phage lifecycle'.

There are two cycles, while certain bacteriophages reproduce only via a lytic cycle, other bacteriophages alternate between a lysogenic lifecycle and lytic lifecycle. In a lytic lifecycle, the bacteriophages cause lysis of the targeted bacterial cells by bursting the cell wall of bacteria. In a lysogenic lifecycle, the bacteriophages doesn't kill the targeted bacteria cell, instead they are replicated along with the bacterial cell DNA every time the cell divides.

Lytic Cycle

The characteristics of a bacteriophage in a lytic cycle is typical to that of a virus; after attachment to their targeted bacterial cell the resources of the cell is utilised to produce new phages. This causes the cell to burst and lysis of the bacteria.

The phases of the lytic cycle:

- Binding: The bacteriophage tail attaches to a specific receptor present on the bacterial cell's surface.
- Invasion: The phage genome enters the cytoplasm of the bacteria.
- Biosynthesis: The phage DNA replicates and translates the important viral components to make phage proteins.

- Maturation: New phage particles are created.
- Lysis: The cell expands and bursts releasing the newly created phages.

Lysogenic Cycle

In the lysogenic cycle, the initial two phases are identical to that of the lytic cycle. However, after the phage DNA enters the cell, it recombines with the bacterial chromosome causing the phage genome DNA to integrate into the chromosome. The integrated phage DNA is also known as a prophage. Thus, every time the bacteria replicates its chromosome, the phage's DNA is also replicated and passed along to new cells during reproduction.

The phases of the lysogenic cycle:

- Binding: The bacteriophage attaches to the host.
- Invasion: It injects the DNA into the host cell.
- Integration: The DNA of the phage recombines with bacterial chromosome.
- Cell Division: The phage DNA is passed onto the new cells after cell division.

If the conditions become stressful, the prophage DNA comes out of the bacterial chromosome to enter the lytic cycle.

Bacteriophages - Alternative to Antibiotics

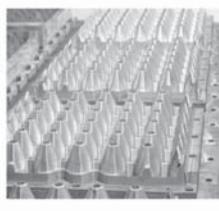
Before Alexander Fleming discovered antibiotics in 1928, considerable research was conducted on bacteriophages to treat bacterial infections. Though research on phage was abandoned in various parts of the world post the discovery of antibiotics, but in different Soviet nations the developments continued mostly because of the lack of western antibiotics. Of late, owing to increasing problems of antibiotic resistance, there has been a resurgence of interest in the "phage approach".

In fact, bacteriophage therapy is being used nowadays to help fight different bacterial diseases in animal and poultry. Leading the way, Proteon Pharmaceuticals has emerged as a prominent name focused on improving animal and human health with their sustainable bacteriophage products and solutions. Using precision biology for microbiome protection, Proteon Pharmaceuticals aims to reduce the unnecessary use of antibiotics to enhance on-farm productivity and enhance environmental sustainability of livestock production.



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Organic Poultry Farming in India

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The poultry population of India grew at an exponential rate of 16.8% from 2012 to 2019 taking the number to 851.8 million last year. When it comes to animal agriculture in India, the poultry sector was valued at INR 1,750 billion in 2018. The market is further projected to reach INR 4,340 Billion by 2024, growing at a CAGR of 16.2% during 2019-2024. With changing consumer



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preference and increased health awareness, there has been a sudden shift of attention towards sustainable organic poultry farming in India. Poultry farmers in India are starting to realise how a small shift from conventional systems can benefit the animals, consumers, and of course, their business.

Issues with Conventional Poultry Farming

Over the last four decades, the poultry sector of India has transformed immensely to become a scientific, commercially organised industry. However, a major part of the poultry industry is still dependent on conventional methods that not only violate animal welfare but also cause expanding use of antimicrobials in poultry.

As a consequence of the growing demand for animal protein and use of antibiotics, drug-resistant infections in poultry and humans have become a serious issue. Under conventional systems, the use of antibiotics without any proper regulatory limits poses a serious threat of antibiotic resistance. Though in 2014 the Department of Animal Husbandry advised controlled use of antibiotics in animal feeds, so far it has made no difference.

According to the National Environmental Engineering Research Institute (NEERI), Arsenic is fed to chickens to promote growth and weight gain with less feed. The long term exposure to this

substance can cause cancer. Growth hormones given to the fowls is another issue related to the health of the consumers.

Besides the growing use of antibiotics, conventional poultry farming practices also result in poor management of litter, manure, and wastewater that can adversely affect the lives of people.

How Organic Farming can be a Better Substitute

The "naturalness" of organic poultry farming can be a suitable alternative to conventional poultry farming methods. Organic poultry farming will result in birds having better outdoor access, low stocking densities, an organic diet, and treatment methods for diseases that do not use chemicals.

In 2014, the Center for Science and Environment conducted a study on 1500 samples from 530 birds on 18 poultry farms in 6 districts in Punjab to test their resistance to a variety of antibiotics crucial to human medicine. High levels of resistance to many important antibiotics were found – 39% for ciprofloxacin and 89% for nalidixic acid.

Even more alarming reports were shared by the *Science* journal recently stating that 4,796 tons of antibiotics will be fed to animals reared for food by 2030 if proper regulations are not put in place.

Unlike conventional poultry farming, organic poultry farming requires that poultry is raised without antibiotics, synthetic pesticides, hormones, and mammalian byproducts in the feed. To prevent the spread of diseases and counter antibiotic resistance, a new approach is being adopted across poultry farms globally i.e. bacteriophages. Bacteriophages are viruses that bind with the bacteria, replicates, and kills it by bursting or lysing. Bacteriophages are very specific and can be a

Poultry Population in India	Grew at 16.8% from 2012 to 2019 taking the number to 851.8 million
Poultry Industry In India Valuation in 2018	INR 1750 billion
Poultry Market in India 2019-2024	Expected to grow at 16.2% to 4340 billion by 2024
In 2014 Department of Animal Husbandry	Advised controlled use of antibiotics in animal feeds
In 2014, the Center for Science and Environment conducted study on 1500 samples from 530 birds on 18 poultry farms in 6 districts in Punjab	High levels of resistance to many important antibiotics were found across the board

better substitute for reducing the use of antibiotics in poultry. Bacteriophage based disinfectants are also helpful in preventing horizontal transmission of pathogens.

Wrapping Up: There is a severe lack of technical knowledge among poultry farmers in India that leads

to the acceptance of sub-standard practices. As a result, flock health is affected. Use of organic poultry farming procedures would lead to safer poultry products through proper poultry welfare. This would also make sure that consumers face no risk of infections from the consumption of poultry-based products like egg and meat.

Free Lance Poultry Consultant

DR.MANOJ SHUKLA, a renowned poultry Veterinarian, with 20 years of enriched field experience, now started Free Lance Poultry Consultancy. In the past 20 years have contributed to the development of the hatcheries in various capacities of leading companies across India - Maharashtra, Gujarat, Madhya Pradesh, Chhattisgarh, Orissa, Bihar, West Bengal, Jharkhand, North-East, Uttar Pradesh and neighbouring country of Nepal.



His areas of expertise include:

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- Commercial Broiler Management
- Nutrition (Feed Formulations).
- Breeder Management.
- Sales & Marketing of Day-Old commercial Layer chicks, Broiler chicks & Poultry Feed.
- Sales & Marketing of Broiler Breeder.
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As a strategic partner, Poultry Line wishes Dr. Shukla every success in his new assignment

Management of Poultry Birds during Winter Season

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Winter season has great effect on poultry production due to low temperature of the surrounding. As the temperature goes down below 10°C during this season, various problems like reduction in egg production, reduction in water intake, reduction in fertility and hatchability etc. occurs. Therefore, proper management of poultry during winter is an important concern for poultry farmer. This white paper will attempt to shed some light on the following points which should be considered to get better production from poultry during winter season.

Orientation Of House

Poultry house should be designed in such a way in order to provide all the comfort required by birds during winter. Orientation of a building with respect to wind and sun consequently influence temperature, and light on different external surfaces. In winter the arc of the sun's visible path is shortened, an east-west alignment of a rectangular house provides a maximum gain of solar energy in winter. House should be designed in such a way that maximum sun light enters the shed during day time. Birds should be protected from chilled winds, hence gunny bags should be hanged at the places from where the cold air enters. These gunny bags should be hanged down immediately after sunset in the evening till the arrival of sunlight in the next morning.

Ventilation

During winter season it is necessary to provide plenty of ventilation to make sure that the chicks have adequate fresh air. Birds release a lot of moisture in their breath and droppings which adversely affects their health. If there is restricted ventilation it causes ammonia build up in the air which causes respiratory problems. So, poultry birds need plenty of fresh air circulating around the house. During winter the outside temperature will be a lot cooler than the inside temperature. Farmer must make sure that the incoming air mixes sufficiently with the warmer air and not to fall directly onto the chicks. With an open-sided house this may be done by reducing the opening in the curtains to speed up the incoming air or by adding a second interior curtain that is attached

to the base of the wall and open at the top. There should also be arrangement of exhaust fans to remove impure air. During warm months, the purpose of these exhausts fan is to remove heat and control the temperature in the house, and therefore large amounts of air are moved. However, in winter season, the ventilation system is required to remove moisture and gases, especially ammonia. But at the same time it helps in conserving the heat. This is tricky because producers tend to keep houses closed up tight to conserve the heat. It is done by controlling air inlets and is possible because warm air holds more moisture than cold air does. Therefore, during cold weather producers can bring small amounts of air into the house with high moisture in the air, allow the fresh air to heat to room temperature, and when this air leaves, it takes moisture out of the house.

Light Management

When the season changes from summer to winter, there is a reduction in egg production. Chickens are stimulated to lay eggs by day length. Long days and increasing day lengths encourage egg production. In winter the day length declines from about sixteen hours per day to a low of eight hours per day in December. Declining and short day lengths will result in reduced egg production in most hens.

To reduce the effects of reduced day length on egg production, an arrangement of artificial lighting may be made to remain in production. Lights in the chicken house that keep the day length at above about 14 hours per day will keep hens laying well through the fall in winter months. Only low wattage lights are needed, a single 25 to 40 watt bulb on a timer that turns the lights on before sunset and off at about 10 pm is sufficient. With some attention to management requirements, the hens will remain healthy and productive throughout the fall and into winter.

Temperature Control

To ensure maximum chick uniformity to achieve provide constant house temperatures, especially

during the first 5 days during winter season. Fluctuating temperatures will hamper the gastrointestinal tract development. The chicks are not able to regulate their own body temperature during the first week and fluctuating temperatures will increase variance. It is very much needed to preheat the brooder houses at least 48 hours prior to placing the chicks. Ensure that your floors are at least 28°C. Floors would be heated more rapidly if you start warming of the house can be started before covering it with bedding. The bedding can insulate the floors from the heat and lock in the cold underneath. When placing the bedding material, it should be at least 4-5 cm thick. The bedding temperature should be 32°C with air to air heaters and 40.5°C directly under the brooder. The bedding can insulate the floors from the heat and lock in the cold underneath.

During the winter temperatures fall rapidly, especially in the evening and early mornings. One should take care that the heaters are responding to these temperature fluctuations. One way to monitor this is by placing thermometer in the houses. Placing multiple thermometers at different locations in the house will give a better picture of how the heat distributes through the house and the uniformity of the temperature. Thermometers should be placed at bird height. Remember that the birds' behaviour is the most important indicator and must be monitored regularly by checking whether they are huddling, panting or migrating. Healthy chicks will be distributed evenly throughout the house. Chicks should always be spread evenly throughout the house with eating and drinking. It is probably a good idea to do maintenance on heaters and curtains now to ensure that they are ready to keep out the cold for the next few months.

Litter Management

The litter gives warmth to the birds during winter. If litter management is proper, it will be felt quite warm when taken in hand. Prior to chick being placed in house, the surface of floor should be covered with a bedding material called litter. It gives comfort to the birds. A good quality litter serves as an insulator in maintaining uniform temperature, also absorbs moisture and promotes drying. It dilutes faecal material thus reducing contact between birds and manure. It also insulates the chicks from the cooling

effects of the ground and provides protection cushion between bird and floor. Around 6 inches of litter is needed in houses during winter.

Space Management

Floor space of broilers depends upon their body weight, housing system and climatic condition of that region. In winter season, the space allowance can be reduced by 15% of the recommended space requirement in normal tropical condition.

Weeks	Normal tropical climate (sq. Cm/bird)	In winter (sq. Cm/bird)
2 weeks	120	102
4 weeks	367	312
6 weeks	730	621
7 weeks	945	830

Humidity Management

The aim should be to maintain a relative humidity level in the house of between 50 and 70% by supplying sufficient air and added heat when necessary. The ventilation rate must always be maintained at a level sufficient to ensure that ammonia does not approach the threshold level of 25ppm. In winter season this may necessitate increasing heating levels in the house.

Feed Management

As temperature drops, the birds need more calories of energy to maintain their body temperature. The birds will consume more feed to compensate the heat loss from the body. It results in poor feed efficiency. When the birds consume more feed then automatically protein and other nutrient intake will be more. Hence, protein and other nutrients in excess may be used for energy production which is nothing but a wastage and expensive too. In such condition, the energy content of feed can be increased by adding fat and oils. Alternatively, the protein and other nutrient content can be reduced keeping the energy at same level.

The variation in feed consumption is smaller for each degree Fahrenheit change in temperature when the weather is cold than when it is hot. Low temperature causes more feed intake and higher oxygen demand. Therefore, when the weather gets colder, it is essential to give the chicken plenty of food as they require extra energy for maintaining body

temperature. Consumption of calories of ME/bird/day varies as the ambient temperature changes. Normally, ME requirement per bird in summer and winter is 240-270 and 280-320 kcal/day.

In winter number of feeders should be increased as compared to summer. Feed should be available to the bird whole of the day. It has been experimentally proved that for proper growth of broiler during summer, diet containing 23% protein and 3100 Kcal ME/kg diet is needed. While in winter 3400 Kcal/kg ME and 23% protein is needed.

Water Management

During winter season birds take less water so far maintenance of water in the body, it is necessary to give continuous supply of fresh water which can be taken by the bird. Water must be fresh and clean. If water is cold enough, then it should be given to poultry birds after adding hot water to it, so that the water comes to normal temperature. In ice falling areas, blockage of pipe is a big problem due to freezing of water during winter season. When temperature goes below 0°C routine inspection of pipe line should be done to avoid blockage of water.

Medicines And Vaccine Management

Throughout the year many of vaccines, medicines, anti-stress vitamins are being given to poultry through water. But, water consumption of bird is reduced during winter season. Hence, care should be taken that waterers are removed few hours prior to water medication and medicine or vaccine is given in less amount of water so that birds can consume total water and each bird get benefit of medicine, vaccine or other supplements.

Disease management:

Ascites (Water Belly) in Broiler

Ascites (or water belly) is extremely common during cooler season. It is a condition of fast growing broiler chickens in which the excess amount of fluid accumulated in the abdominal cavity. It has become major concern to the poultry industry around the world. Ascites is associated with inadequate supply of oxygen, poor ventilation and respiratory disease complex aetiology. Morbidity is usually 1-5%, mortality 1-2% but can be up-to 30% at high altitude. Chilling

is a common cause in small flocks. It causes an increased blood flow through the lungs. In order to minimize ascites (water belly) air quality should be kept fresh by moving air regularly and efficiently. In the colder months, it is better to add heat and keep the air moving than to shut down vents or reduce airflow in an effort to conserve heat. Careful attention to brooding temperature in winter season is also critical for minimizing water belly. The objective is to minimize progression leading from pulmonary hypertension to terminal ascites or water belly condition for availing better profit during winter season.

Fowl pox:

Outbreaks of fowl pox can occur during winter and early spring. There are two forms of fowl pox. The cutaneous form is characterized by raised, wart-like lesions on featherless areas (head, legs, vent, etc.). The lesions heal in about two weeks. If the scab is removed before healing is complete, the surface beneath is raw and bleeding. Unthriftiness and retarded growth are typical symptoms of fowl pox. In laying hens, infection results in a transient decline in egg production. In the diphteritic form lesions are found in the mouth, pharynx, larynx, and trachea. The diphteritic form may cause respiratory distress by obstructing the upper air passages. Chickens may also be affected with both forms of fowl pox at one time. As no treatment is available for such viral disease, vaccination is recommended to stop an outbreak. The wing-web vaccination method is used for chickens. Fowl pox outbreaks in poultry confined to houses can be controlled by spraying DEET (chemical name, N,N-diethyl-meta-toluamide) to kill mosquitoes.

Conclusion

Winter is one of the important environmental factors that can affect the performance of poultry. Factors like optimum temperature, light, and ventilation management play an important role in overcoming ill effects of winter season on birds' performance. We should also take into consideration onto various points as discussed above to manage space, litter, feed, water, humidity, disease, etc. in order to get maximum profit through better growth performances of the birds.

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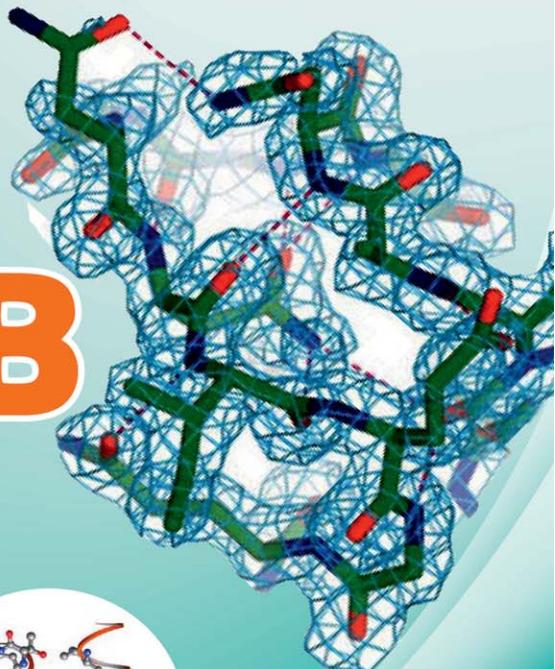
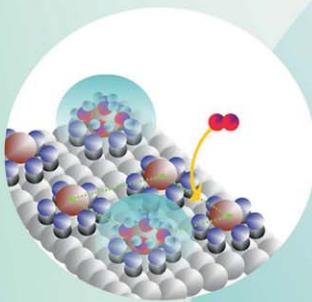


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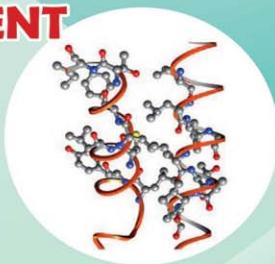
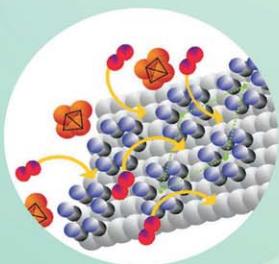
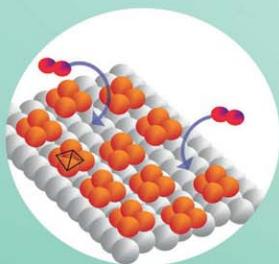
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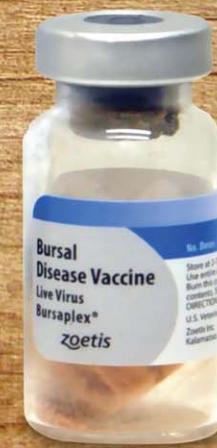


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Technical Update

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UNDERSTANDING THE ROLE OF THE SKELETON IN EGG PRODUCTION

Soft bones and thin fragile bones are issues that affect producers of high-performing egg layers all around the world. Osteomalacia and osteoporosis most commonly arise from deficiency, imbalance or malabsorption of calcium, phosphorus, or vitamin D₃. The effect of skeletal issues on a flock typically is demonstrated by decreased production, crooked keels, fractures and poor shell quality.

All hens require a specific amount of nutrients to maintain production and skeletal structure. The skeletons and dietary requirements of hens are unique relative to the level of calcium consumed and the amount of bone that is constantly being built and resorbed. When soft bones or poor shell quality is found, usually at least one of the following factors is involved: pullet growing, nutrition, feed consumption, or disease.

GLOSSARY

Crooked: not straight; having curves

Labile: constantly undergoing change

Osteomalacia: decalcification or softening of bones due to bone mineralization issues caused by insufficient levels of available phosphorus and calcium or due to excessive resorption of calcium from the bone

Osteoporosis: a progressive bone disease resulting in decreased bone mass and density

Resorb: to dissolve/break down and assimilate

Resorption: destruction or loss of tissue or bone



OVERVIEW OF BONE BIOLOGY

The avian skeleton is a unique system that is specialized for flying, walking on two legs and laying eggs. Establishing and maintaining a strong skeleton is vital to ensure a productive laying hen. In order to understand the impact of diet on the laying hen, it is important to understand the biology of the skeleton. There are three different types of bone: cortical, trabecular and medullary.

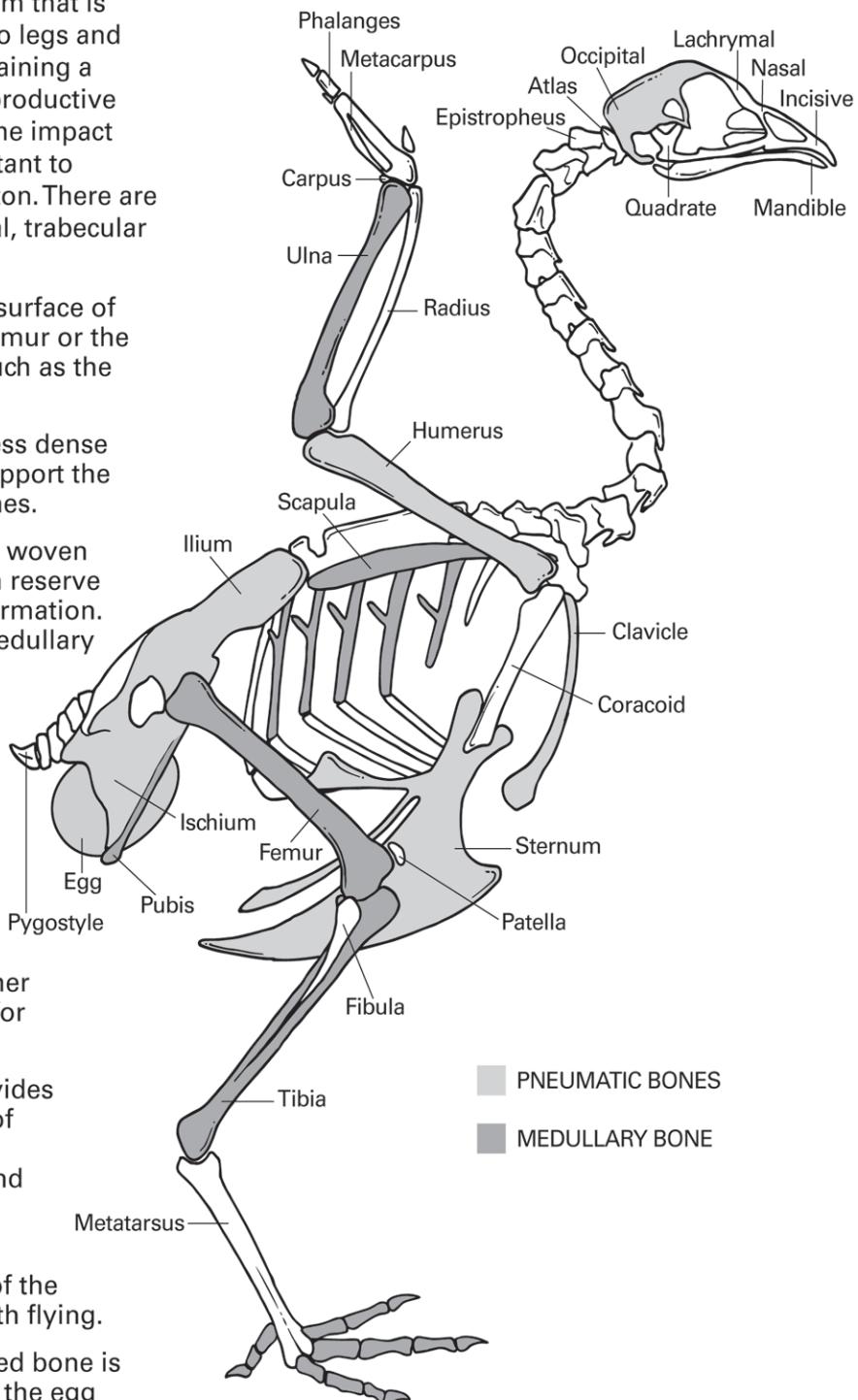
- Cortical bone is the hard outer surface of the round bones, such as the femur or the humerus, and the flat bones, such as the skull or the pelvis.
- Trabecular or spongy bone is less dense than cortical bone and helps support the structure inside the cortical bones.
- Medullary bone is a specialized woven bone which serves as a calcium reserve for the demands of egg shell formation. Easily created and resorbed, medullary bone is ideally the first source mobilized when more calcium is required.

While the outside appearance of avian bones is similar to those of mammals, there are several key differences.

- Fused vertebrae – Several thoracic and lumbar vertebral spinal sections are fused together to form a more solid structure for flying.
- Keel – The sternum or keel provides a large surface for attachment of the pectoral muscles which are important for energy storage and muscle yield.
- Pneumatic bones – Hollow and air filled, these bones are part of the respiratory system and help with flying.
- Medullary bone – This specialized bone is used as a source of calcium for the egg shell and only occurs in birds and some reptiles.

Bone growth and resorption is controlled and regulated by a few important cells and many different hormones. In healthy, well-fed birds, the cells and hormones work closely together to maintain bone structure and blood calcium levels needed for optimum production.

The Skeleton of the Fowl



The important cells for bone growth and modelling are chondrocytes, osteoblasts, and osteoclasts.

- Chondrocytes start the basic process for bone growth by secreting type II collagen and other important components for bone formation.

- Osteoblasts then produce the type I collagen and the increased levels of calcium and phosphate that result in the mineralization or ossification of the bone.
- Osteoclasts resorb bone for remodelling or for releasing calcium into the blood stream.

Bone growth and resorption is regulated by a number of different hormones which control when structural or medullary bone grows or resorbs, depending on the physiologic need.

- Growth hormone stimulates cellular growth and protein synthesis throughout the body.
- Thyroxine stimulates cell metabolism as well as osteoblast activity.
- Melatonin influences osteoblast activity. Melatonin levels are highest when birds are sleeping during the dark period and initiate a cascade of events affecting hormones necessary for egg production.
- Estrogen increases at sexual maturity and changes osteoblast activity from creating cortical and trabecular bone to creating medullary bone. After the first egg, the only way a hen can remodel structural bone is during periods of low estrogen, such as molt or breaks in lay during the normal production period.
- Calcitonin is released when there are high serum calcium levels and decreases osteoclast activity while increasing osteoblast activity which builds bone and lowers serum calcium levels.
- Parathyroid hormone (PTH) is released during periods of low serum calcium and binds to osteoblasts. This binding decreases osteoblast activity while releasing a compound that increases osteoclast activity, thus increasing serum calcium levels. Additional properties of PTH include increasing small intestine absorption of calcium and decreasing urinary excretion of calcium.
- Calcitonin and parathyroid hormone work together in feedback loops to ensure the proper levels of serum calcium are maintained.

THE IMPORTANCE OF GOOD QUALITY PULLETS

A strong skeleton starts with good pullet quality. Best management practices should always be used when growing pullets. Please refer to the Hy-Line International Technical Update "Growing Management of Commercial Pullets" for information regarding pullet programs.

Chicks hatch with relatively underdeveloped internal organs and systems. The main systems that are developing in the initial weeks after hatch are the intestinal tract, the immune system and the integument (skin and feathers). The development of the intestine is crucial for nutrient absorption and will determine a hen's future production efficiency. Strong intestinal development will also strengthen the immune system and minimize the possibility of future enteric diseases.

Starting at about six weeks of age, pullets have a more mature intestinal tract and immune system and also are able to regulate body temperature which allows for more energy to be allocated for growth. The fastest rate of growth for the skeleton occurs between 6 and 12 weeks of age. During this time period, layer pullets gain an average of 90 to 110 grams of body weight per week. By 12 weeks of age, the skeleton is 95% developed and once the bone growth plates close around the time of sexual maturity, no more bone length can be added. Any delay in growth will affect the size of the mature bird and delay the onset of production.

At 13 weeks of age pullets have reached about 95% of their adult size, but only 75% of their mature weight. Over the next 6 weeks muscle, medullary bone and reproductive tract development will constitute much of the weight gain. Once birds have reached the appropriate level of development as determined by body weight, the flock will be ready for light stimulation to start egg production. Laying hens will continue to add muscle and bone mass and gain weight until around 32 weeks when the full mature body weight is achieved.

A pullet flock that experiences higher levels of stress during periods of rapid growth is more likely to have poor uniformity that can affect peak production. When a flock lacks uniformity, the lighter birds will not come into production

for up to 10 weeks after birds that meet or exceed ideal body weights. Therefore while most of the flock may be laying at 96%, the 5% of the flock that is underweight may be laying sporadically (or not at all) and will reduce the peak production percentage. Stressors that may be avoided include moving, injecting with inactivated vaccine, wide ranges of environmental conditions inside the house, poor feed quality, crowding and any other abrupt changes in routine.

Crowding in the pullet house usually starts to affect birds at approximately 10–12 weeks when the skeleton is near full size. Crowded pullets will have issues with uniformity and body weight gain until transfer. Refer to the Performance Standards Manual for rearing space recommendations.

Measuring body weight gain and uniformity is an excellent method for tracking flock growth throughout pullet growing. Higher body weights result in larger skeletons and more muscle mass which leads to better production. Waiting to light stimulate until target weights are met is the most effective solution to ensure good persistency of lay and avoid a post-peak dip in production. Monitoring body weights every week should not stop at transfer. It is ideal to weigh every week up to 32 weeks of age and at least every 2 to 4 weeks until the end of lay. This practice will give an indication if nutrient intake is sufficient to support production, growth, and maintenance requirements of the bird.

SEXUAL MATURITY IN THE LAYING HEN

About two weeks prior to egg production, the hen will undergo sexual maturity. An increase of estrogen will stimulate development of the oviduct, reddening of the comb and wattles and a complete transition from building skeletal bone to building medullary bone.

To aid the growth of medullary bone before the first egg, it is recommended to introduce more calcium through the use of a Pre-Lay Diet. Constantly improving genetics provide producers with layers capable of very high peaks of lay and good persistency. To ensure that genetic potential is reached, building medullary bone and formulating diets with sufficient nutrient density to meet the daily requirements of the bird is very important. However, there can be a negative impact on feed consumption from the sudden increase in dietary calcium

levels of 1% to above 4% at the start of lay. Field experience indicates that the use of Pre-Lay Diets helps as a transition between the Developer and the Peaking Diet. Correct feed formulation and matching diet density with consumption will minimize the impact of reduced calcification of bone over the laying cycle and extend the persistency of shell quality.

BONE QUALITY DURING PRODUCTION

The length and width of the poultry skeleton is complete when the hen has started to lay. However, the bone mineral density and content, as well as the ratio of cortical, trabecular and medullary bones can change dramatically. The laying hen skeleton is strongly influenced by level of egg production, diet formulation in relation to consumption and disease status. A well-grown laying hen will typically not face skeletal issues until after peak, even with mild to moderately deficient diets. With an underweight laying hen, nutrient deficiency will more quickly affect flock results. Mild to moderate nutrient deficiencies will usually cause skeletal and/or shell quality issues first with production issues following. Severe nutrient deficiency will still cause noticeable and rapid drops in production.

Many animals, including birds, experience thinning of the cortical and trabecular bone thickness with age. Laying hens also experience changes in overall bone strength. Although medullary bone is the most labile bone type, if a hen is calcium deficient, cortical and trabecular bone will also be mobilized as a calcium source. During the laying period, hens have been shown to have a net increase in bone mass as a result of medullary bone formation and the loss of structural bone. However, without a molt or cessation of production due to nutrient deficiencies, the constant high level of estrogen in a laying hen will prevent the repair of structural bone. Loss of cortical bone can result in crooked keel or bone fractures, both of which are detrimental to hen welfare and production.

As birds age, medullary bone content will increase while structural bone integrity typically decreases. Birds that lose too much cortical bone and gain medullary bone can have good shell quality, but are at a higher risk for keel curvature or bone fracture. The best way to minimize the loss of cortical bone is to ensure that the correct levels of calcium, phosphorus and vitamin D₃ are fed throughout the lay cycle.

Preventing loss of skeletal integrity starts with the pullet, but continues through the life of the bird. It is also important to understand the clinical signs of osteomalacia, osteoporosis and osteopenia and make the appropriate changes as soon as possible.

MONITORING SKELETAL INTEGRITY

The best way to minimize the impact of soft bones in a flock is to monitor regularly. Handling birds while weighing is the ideal way to collect this information. Select birds from the same cage, colony or section of the barn at least every 4 weeks to ensure consistency of data and provide early notice if crooked keels are observed.

- Keels are scored by feel and observation. The Hy-Line method is to score on a four point scale based on normal (#1), mild (#2), moderate (#3) or severe (#4) curvature.
- At the beginning of calcium, phosphorus or vitamin D₃ deficiencies, keels may be flexible, but not yet curved. This is an important clinical sign to note.
- Hens with recalcified, curved keels would indicate a nutritional deficiency earlier in the life of the flock.
- It is ideal to handle a minimum of 10 birds in at least 2 to 3 areas of a barn.

Overall, it is ideal to have greater than 90% of birds handled in the Score 1 or Score 2 category. More than 10% Score 3 or Score 4 birds, or increasing numbers every week, indicate the possibility of an issue.

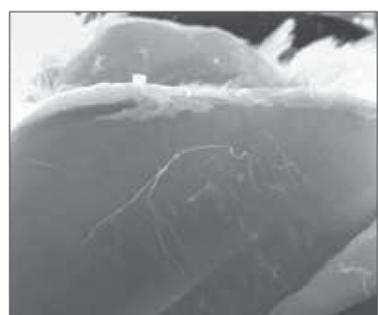
#1 – Normal Keel



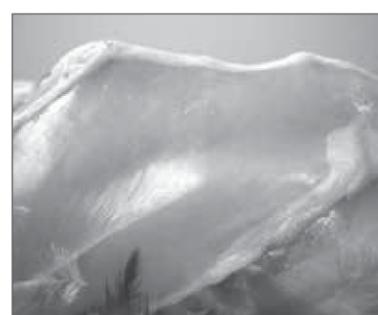
#2 – Mild Curvature



#3 – Moderate Curvature



#4 – Severe Curvature



NUTRITION

Feed consumption and nutrition always go hand in hand. All diet formulations must be based on feed consumption to ensure proper intake of the critical nutrients. As a result, all Hy-Line diets are recommended on the basis of total daily feed intake. Focusing on calcium and available phosphorus, as examples, the Hy-Line Brown and Hy-Line W-36 need to consume the following amounts each day in her ration:

	Peaking Diet		Lay Diet #2		Lay Diet #3		Lay Diet #4	
	Hy-Line Brown	Hy-Line W-36						
Calcium (g/day)	4.20	4.10	4.30	4.30	4.50	4.45	4.80	4.60
Available Phosphorus (mg/day)	460	485	420	470	380	450	360	400

Attaining the required levels for these nutrients is significantly dependant on daily feed consumption. A sample calculation for a bird recommended to have 4.00 grams of calcium per day and with an observed feed consumption of 95 grams is as follows:

$$\frac{4.00 \text{ g calcium}}{95 \text{ g feed consumed}} \times 100 = 4.21\% \text{ calcium in the diet}$$

Limestone particle size is also important for optimum shell quality. Pullets should have fine particle calcium, ideally less than 1.1 mm (1100 micron) average. It is best to use limestone flour for pullets as the smaller particles are more easily absorbed.

Layers should ideally receive a 50:50 ratio of large and fine particle limestone at the start of lay and transition to a 65:35 ratio (large: fine) by the end of lay. Changing the particle size ensures that more calcium will be available at night from the diet instead of from the bone. Further measures to increase night calcium availability include ensuring a last feeding 1–2 hours before lights are turned off and adjusting the feeding regime to 40% in the morning and 60% in the afternoon.

The large particle fed during lay should be around 2–4 mm (2000–4000 micron) average size with an ideal 3 mm (3000 micron) size. When calcium particle size is above 3.5 mm (3500 micron), the solubility rapidly decreases.

If the hen is not effectively absorbing the calcium in the diet, she can be deficient (even with an accurate “calculated value” of the ration).

Additionally, the source of limestone should be checked. Low calcium content limestone (less than 37%) may contain other minerals that reduce the solubility (and therefore the calcium availability).

Depending on geological formation, different limestone structures exist which may also affect solubility and availability.

Phosphorus intake is similarly calculated, although the requirement definition is more complex due to different systems used to express available and digestible phosphorus. Care needs to be taken that requirements and the availability matrix are being expressed on the same system. There are ongoing projects in the US and the EU to review the phosphorus nutritional systems and create a more universal standard.

The use of phytase enzymes must be considered when formulating the diet. Phytase is an important tool in reducing both the cost and environmental burden of animal feeding; however care needs to be taken when applying matrix values. Matrix contributions need to be accurate for the phytase being used, the diet in which it is being used and the dosage being applied. The matrix contribution must not exceed the concentration of phytate phosphorus potentially available for release. This differs by phytase source, inclusion rate and the ingredient makeup of the diet.

Vitamin D₃ (cholecalciferol) is a critical nutrient that aids in calcium and phosphorus uptake in the small intestine, bone mineralization, inhibition of calcium excretion in the urine and immune system modulation. Vitamin D is typically included in the feed as vitamin D₃. It is absorbed in the small intestine and converted to 25-hydroxycholecalciferol in the liver.

This metabolite is then converted to the active form of 1, 25-hydroxycholecalciferol in the kidneys. Instead of vitamin D₃, 25-hydroxycholecalciferol can be used as a supplement for the hen. A more biologically active metabolite of vitamin D₃, 25-hydroxycholecalciferol provides a higher dose of vitamin D at a lower inclusion rate.

Other dietary factors are also important to consider in the efficiency of bone calcification and eggshell formation. This includes the acid base balance of the diet (or dietary electrolyte balance - DEB), vitamin K, zinc, copper, iron, manganese and magnesium. Some essential amino acids which are often limiting in laying diets (valine and arginine) may be important due to their role in calcium transportation and formation of the bone matrix.

FEED CONSUMPTION

Consumption volumes at the start of lay change quickly; for example, the Hy-Line Brown eats 80–90 g/day at the start of lay and soon eats 110–115 g/day in about 4–6 weeks at peak production. Often, feed mills may only have one Peaking Diet that is formulated for 110–115 g/day intake for brown birds and 100–105 g/day for white birds. When intake at the start of lay is only 80–90 g/day, there will be deficiencies of 20–25% in calcium, phosphorus, essential amino acids and other nutrients. Creating a diet matrix can help ensure that the correct dietary formulation is used. Not all diets will be used, but it will simplify ordering feed for a farm.

	Peaking Diet	Lay Diet #2	Lay Diet #3	Lay Diet #4
Daily Feed Consumption				
90 g/day	x			
95 g/day				
100 g/day	x			
105 g/day				
110 g/day	x	x	x	x

The bird is still growing until about 32 weeks and is adding muscle mass and bone density. If there are deficiencies in the diet, the impact may not be immediate, but can be felt late in lay when hen body reserves have been depleted.

DISEASE

Nutritional issues are usually the primary cause for decreased skeletal integrity and resulting shell quality problems. However, many subclinical respiratory and enteric diseases may have the same effect. A decrease in feed consumption or nutrient absorption can have a dramatic impact on shell and bone quality as described previously. Bacterial, viral or protozoal pathogens may cause temporary or permanent damage to the intestine and reduce the absorption of key nutrients. The duodenum in particular is the location in the intestine where calcium is actively absorbed in response to increased demand under hormonal influence involving vitamin D₃. Diseases such as focal duodenal necrosis can damage the duodenum and may decrease the efficiency of absorption. Additionally, there are many diseases that cause shell quality issues by affecting the oviduct, including infectious bronchitis, Newcastle disease, *Mycoplasma synoviae*, egg drop syndrome (EDS) and avian influenza.



ACTIONS WHEN SKELETAL ISSUES ARE IDENTIFIED

During routine handling, if soft bones or crooked keels are detected during lay, there are steps that can be taken to correct the issue.

General – should only be used until specific measures can be taken

- Add water-soluble vitamin D₃ or 25-hydroxycholecalciferol to the drinking water 1–2 times a week to increase calcium and phosphorus metabolism
- Add 2–4 mm large particle limestone or oyster shell to increase the level of calcium in the gizzard overnight and provide calcium for egg shell and strengthening bones.
- Review, and if necessary, increase the level of available phosphorus in the diet to help with bone strength and metabolism

Specific

- Verify or determine feed consumption of the flock
- Check the feed formula to ensure the correct amounts of calcium, phosphorus and vitamin D are specified
- Ensure that the daily levels of consumption meet the dietary needs of the hen
- Send feed samples for analysis to determine if calcium and total phosphorus levels are consistent with formulated values. When sampling, it is important to obtain a representative sample of the feed to minimize sampling error. A standard procedure for collecting accurate feed samples is to collect multiple sub-samples and mix them together. Use a portion of this mixed sample to send in for analysis.
- If a deficiency is found, work with the feed mill to prepare the correct formulation based on daily consumption
- Check the flock to see if there are any disease issues that are minimizing absorption or reducing feed consumption

Ensuring good skeletal development from rear into lay through best management and nutritional practices is essential to reach the genetic potential of the Hy-Line layer. Understanding the importance of the skeleton in laying hen production will help producers implement best practices. Formulating the diet to consumption and monitoring the skeletal quality will create the environment to attain the best and most economical production.

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* D. Michael Fry - Department of Avian Sciences, University of California, Davis, California - Environ Health Perspect 103(Suppl 7):165-171 (1995)

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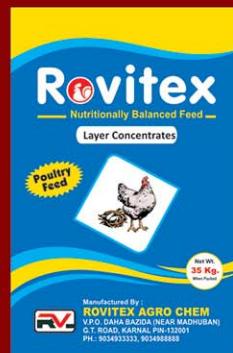
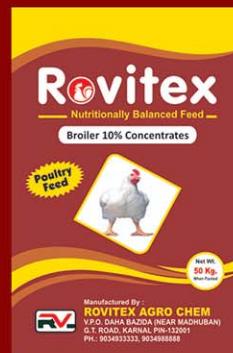
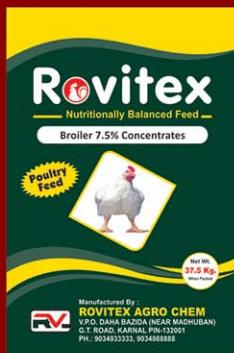
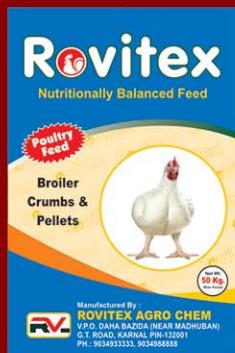
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- ❖ Broiler 7.5% Concentrates
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- ❖ Broiler 3.5% Concentrates
- ❖ Broiler 2.5% Concentrates
- ❖ Broiler 1.5% Concentrates

Layer Concentrates:

- ❖ Layer 5% Concentrates
- ❖ Layer 10% Concentrates
- ❖ Layer 25% Concentrates
- ❖ Layer 35% Concentrates

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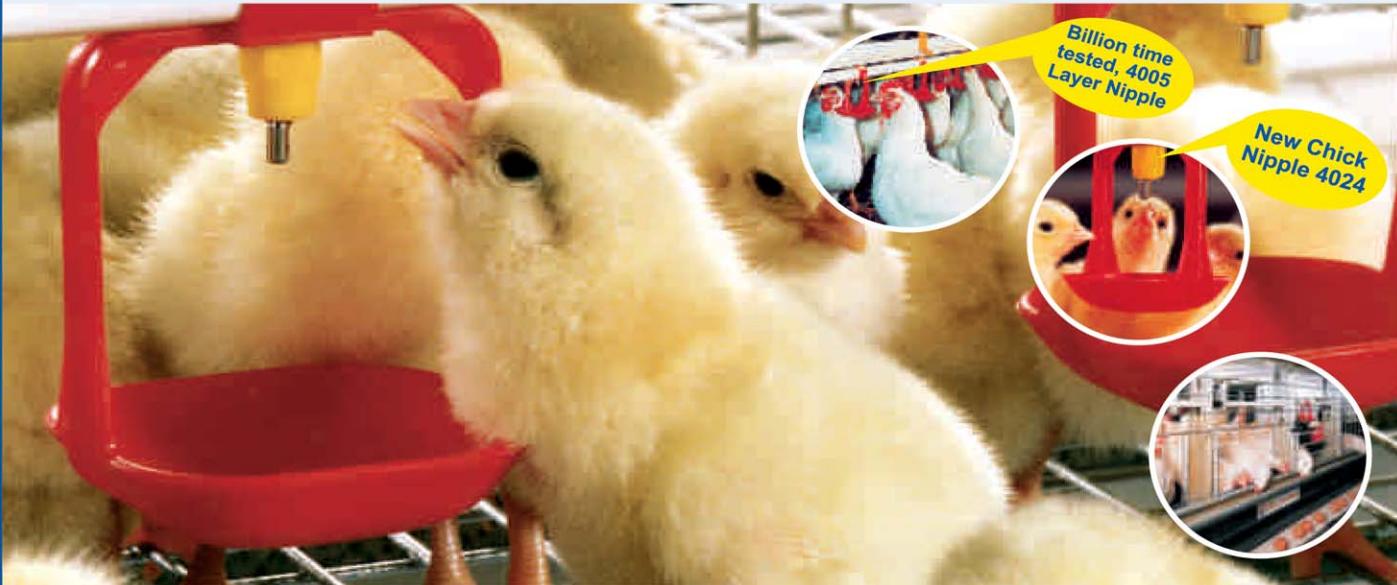
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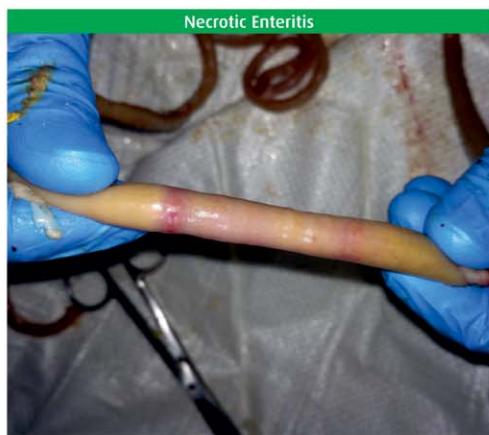
Holistic approach to control NE -Lantibiotics instead of Antibiotics

Dr. Sachin Patil, AGM-Key Clients - Huvepharma SEA (Pune) Pvt. Ltd.

Introduction

Necrotic enteritis (NE) is one of the most important diseases globally, outbreaks of which are estimated to be over \$2 billion annually. In this article, we review the progress on the etiology of NE and its control through dietary modifications, pre and probiotics and AGPs.

The industry worldwide is now facing challenges with the removal of in-feed antibiotics completely or gradually, as the once well-controlled poultry diseases have re-emerged to cause tremendous loss of production. Therefore, the use of alternatives to in-feed antibiotics with a better understanding of the relationship between nutrition and NE, and limiting exposure to infectious agents through bio security, might be a tool to reduce the incidence of NE and to improve gut health in the absence of in-feed antibiotics. **More importantly, the combinations of different measures may achieve greater protection of birds against the disease.** Improvements in housing, genetic selection for growth rate, and advances in feed formulation achieved by matching nutrient requirements of the birds and nutrient contents of the feedstuffs, have resulted in higher meat yield, improved feed conversion and lower mortality rates. As growth rate and feed conversion ratio improve, the



birds' nutrition and health care are becoming more demanding due to production stress with environmental challenges. The nutritional and health status of poultry are interlinked with gut health which includes immune system, gut microbial balance and macro and micro-structural

integrity of the gut. The health of the gastrointestinal tract (GIT) affects digestion, absorption and metabolism of nutrients, disease resistance and immune response. The disturbances of these processes can result in enteric diseases.

Enteric diseases are one of the most important problems in the poultry industry because of high economic losses due to decreased weight gain, increased mortality rates, poor feed conversion ratio and greater medication costs. Many conditions have been associated with gastrointestinal problems such as diarrhoea, wet droppings, dysbacteriosis, intestinal colibacillosis, malabsorption syndrome, Coccidiosis and necrotic enteritis (NE). Enteric disorders are frequently associated with an overgrowth of *Clostridium perfringens*. Infections with this bacterium in poultry can cause NE, necrotic dermatitis, cholangiohepatitis, as well as gizzard erosion. NE is the most common clostridia enteric disease in poultry, which typically occurs in broiler chickens. NE is characterized by necrosis and inflammation of the GIT with a significant decline in growth performance and, in clinical cases, a massive increase in flock mortality.

The primary causative agent of NE is *C. perfringens* and the source of *C. perfringens*. *C. perfringens* is a Gram-positive, spore forming anaerobic bacterium, able to produce several toxins responsible for NE symptoms and lesions. *C. perfringens* can be found in poultry litter, feces, soil, dust,

eggshell, paper pads and chicken dander in the hatchery and in healthy bird intestinal contents. NE usually occurs in broiler chicks at 15 days onwards. *C. perfringens* can be transmitted from a variety of sources, including live flies, walls, dirt outside the entrance, fans, floor, nipple-drinker drip-cups, water pipes, litter material, chick delivery-tray liners and boots of farm staff before chicks were placed.

Clinical NE

The clinical form of NE is associated with signs such as ruffled feathers, relative immobility, depression, anorexia, diarrhoea and decreased appetite. Wet litter is also sometimes an early indicator of the disease.



Subclinical forms

In subclinical forms of NE there is no peak of mortality and no clinical signs are present. Subclinical forms of NE are usually associated with reduced feed intake and weight gain and increased feed conversion ratio. They are also associated with hepatitis and cholangiohepatitis. During subclinical infection, bacteria can reach the portal blood stream and bile duct. Colonization of high numbers of *C. perfringens* in hepatic tissue results in cholangiohepatitis. Gross lesions are usually restricted to the duodenum, jejunum and ileum and also can occur in the caeca. The small intestine of infected birds is friable, dilated, hyperemic, thin walled and filled with gas, and the mucosal surfaces are covered by tan-orange pseudo-membranes and occasional hemorrhages.



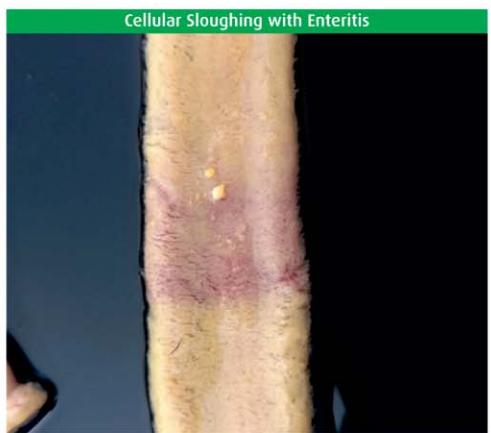
Predisposing factors for necrotic enteritis

Although *C. perfringens* is the primary causative agent of NE in poultry, other contributory factors that alter the microenvironment of GIT and create a favorable environment for *C. perfringens* overgrowth are essential to produce both the clinical and subclinical types of NE. Factors that predispose the bird to NE include co-infection of other parasites most evidently coccidiosis, stress and immunosuppression, and nutrition.

Coccidiosis

The intestinal damage caused by coccidia is an essential predisposing factor for allowing *C. perfringens* overgrowth and production of toxins. Intestinal damage during *Eimeria spp.* infection will result in leakage of plasma proteins into the lumen of the intestinal tract, which is a rich nutrient substrate and favorable for *C. perfringens* proliferation and toxin production. Coccidial infection induces mucogenesis as a result of a host mucogenic response, providing a growth advantage for *C. perfringens*.

Stress and immunosuppression



Any stressful condition in broiler chickens could predispose them to NE, because it could change the intestinal environment in such way that the risk of induction of NE increases, such as stocking density, alteration in feeding phases

moving from a prestarter diet to a starter diet in young chicken etc.
Nutritional factors

The dietary factors play important roles in predisposing the birds to NE infection. However, diets having higher NSPs or containing high protein level may lead to more frequent NE occurrence in broiler chickens. Whereas other nutritional factors such as lectins, trypsin inhibitors and tannins may cause birds to be infected with NE, they are less significant. Attention may need to be paid to reduce levels of NSPs and protein, especially animal protein, in the diets to minimize the possibility of NE. Diets that have a high protein concentration or imbalanced amino acid profiles reduce the digestibility of these compounds in the upper part of the digestive system. Thus the indigestible protein in the lower part of the GIT acts as substrate for the gut microflora. The fermentation of protein produces unfavorable outcomes and increases the pH of the lower part of the GIT, which encourages the proliferation of pathogenic bacteria such as *Clostridium spp.*

Physical form of diet

The physical form of poultry diets may affect the physiological and morphological characteristics of the GIT. Finely ground feed allows *C. perfringens* to grow faster than coarsely ground feed, which can lead to occurrence of NE in the field.

Holistic approach to control NE

Based on the available resources there are three basic strategies used to control NE.

These strategies are

- Amplification of immune response
- Pathogen reduction
- Dietary modification of feed additives

Dietary modifications and feed enzymes

Modification of diet and the addition of enzymes cannot provide total protection against NE, but may reduce the risk of NE by improving digestion. The NSPs in feed increase the digesta viscosity and encourage the development of NE. Also, poultry diets with high protein content, or those rich in animal protein such as meat and bone meal or fish meal predispose birds to NE.

Prebiotics

Prebiotics are generally defined as indigestible feed ingredients that selectively stimulate the growth or activity of beneficial bacteria that are already resident in the GIT. There are several other predominantly used prebiotics like mannan-oligosaccharides (MOS) and fructo-oligosaccharides (FOS)

Probiotics

Probiotics have been defined as "live microbial feed supplements, which beneficially affect the host animal by improving its microbial balance and work on competitive exclusion".



The characteristic of ideal probiotics are that they must be resistant to gastric acids and bile, persist in the intestinal tract, adhere to epithelium or mucus, produce inhibitory compounds, alter immune response and modulate the microflora activity. The modes of action of probiotics include stimulating the immune system, maintaining gut microflora by competitive exclusion, altering metabolism through increased digestive enzyme activity, decreasing bacterial enzyme activity and ammonia production, and neutralizing enterotoxins. The mechanisms of competitive exclusion of pathogens include competitive use of nutrients and mucosal binding sites, low pH and bacteriocins, which are bactericidal or bacteriostatic for pathogenic bacteria. It has been reported that commercial probiotics reduce gross intestinal lesions from NE and improve feed efficiency. Due to this mechanism of action, feeding of normal gut flora to broiler chickens would reduce the *C. perfringens* colonization and decrease the incidence of NE.

Lantibiotics instead of antibiotics

Due to the consumers' growing consciousness regarding the use of antibiotics in animal nutrition and the development of multiple pathogen resistance associated with the practice of using antibiotics on a big scale, alternatives need to be found. One of the promising classes of new antibacterial agents are the so called lantibiotics, which are antimicrobial peptides produced by Gram-positive bacteria and are encoded on the bacterial genome. Lantibiotics have a dual mode of action. Firstly, they form pores, which induces significant thinning of the outer membrane of harmful bacteria making them more vulnerable. Secondly, they inhibit cell wall biosynthesis, challenging the target cell in a severe way. One, which is classified as being a lantibiotic is lichenicidin produced by a strain of *Bacillus licheniformis* and was shown to be effective in the inhibition of *Clostridium perfringens* responsible for producing toxins causing necrotic enteritis.

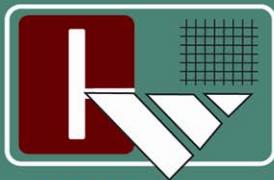
Conclusions

To control NE we need holistic approach with probiotics, prebiotics, NSP enzymes & AGPs like zinc bacitracin (with consideration of proper, recommended withdrawal period).

To know more, please contact Huvepharma technical team



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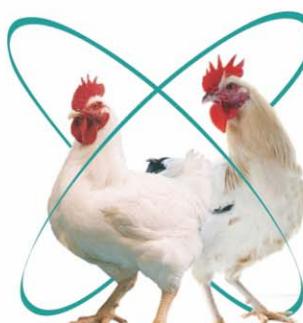
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