

**GLORIOUS
FACETS
OF
CARI**



CENTRAL AVIAN RESEARCH INSTITUTE
Izatnagar-243 122 (U.P.) INDIA



WHAT CARI OFFERS.....

- Elite pure lines, parents and commercial stocks of diversified poultry species.
- Low input improved *desi* (indigenous) chicken varieties suitable for small scale/backyard poultry production.
- Windows® based "MAKEFEED POULTRY" and "MAKEFEED DAIRY" software for formulating least cost and balanced rations.
- Analysis of feed ingredients and compounded feeds for proximate principles, minerals, adulterants and toxicants for quality control.
- Preparation of bankable projects for raising institutional finance under various government schemes for establishing poultry and feed production units.
- Post-graduate education (NDPH, M.V.Sc. and Ph.D. in Poultry Science).
- Short-term training for poultry farmers/entrepreneurs on poultry production.
- Advanced training on layer, broiler, quail, turkey and guinea fowl production management covering all aspects of nutrition, shelter, processing and health care.
- Consultancy projects for undertaking contract research.
- Manufacturing technologies of a wide range of value-added poultry products.





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ACKNOWLEDGEMENTS

All the scientists of the Central Avian Research Institute, Izatnagar are thankfully acknowledged for their valuable inputs, suggestions, technical help and sincere co-operation without which it would have not been possible to bring out this publication.

- Editorial Board



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PREFACE

Poultry includes a variety of domesticated avian species of economic importance such as chicken, duck, quail, guinea fowl and turkey, etc. which have been of interest to human being since time immemorial because of their highly nutritious egg and meat. The poultry sector has been recognized as one of the important segments of our livestock economy for employment generation, upliftment of rural economy and nutritional security. Poultry production system in India has undergone a paradigm shift from the traditional backyard rearing to organized commercial poultry farming over a span of four decades. However, the importance of co-existence of both, mass poultry production and production by the masses is underlined to meet the ever-increasing demand of poultry products and socio-economic upliftment of small and marginal farmers, landless labourers and empowerment of rural women.



The Central Avian Research Institute (CARI), since its inception on the 2nd Nov., 1979 has been playing an important role in providing R&D support for augmenting both commercial (organized) and small scale (unorganized) poultry production. This publication is brought out to mark the 32nd Foundation Day of the Institute and its glorious service to the nation. Over these years, the Institute has contributed substantially to the growth and development of poultry sector by way of developing and supplying high quality genetic stocks of diversified poultry species including their feeding, management and health care practices, apart from low input improved desi (indigenous) chicken varieties for promoting rural poultry production. The Institute has made significant strides in the frontier research areas such as molecular biology and biotechnology towards enhancement of productivity and disease resistance. Besides, appropriate processing technology has been developed for producing a variety of value-added poultry products for the benefit of poultry producers, processors and consumers alike.

*The **Glorious Facets of CARI** presents a brief account of the Institute's major research and technological accomplishments. I extend deep sense of appreciation to all the scientists and other staff members whose contributions are reflected in this publication and also to the editorial board for bringing it out in a concise form. I am sure that the information contained herein will be useful to all stakeholders in the poultry sector.*

November 02, 2010

(R.P. Singh)

Director





Commercial White Egg Laying Chicken

CARI PRIYA

Breeders of egg type chicken are primarily concerned with the development of quality layers in terms of feed efficiency, low chick cost and high egg production. CARI Priya, earlier known as ILI-80, is one such white egg layer. CARI Priya was developed by crossing superior male and female lines of White Leghorn.

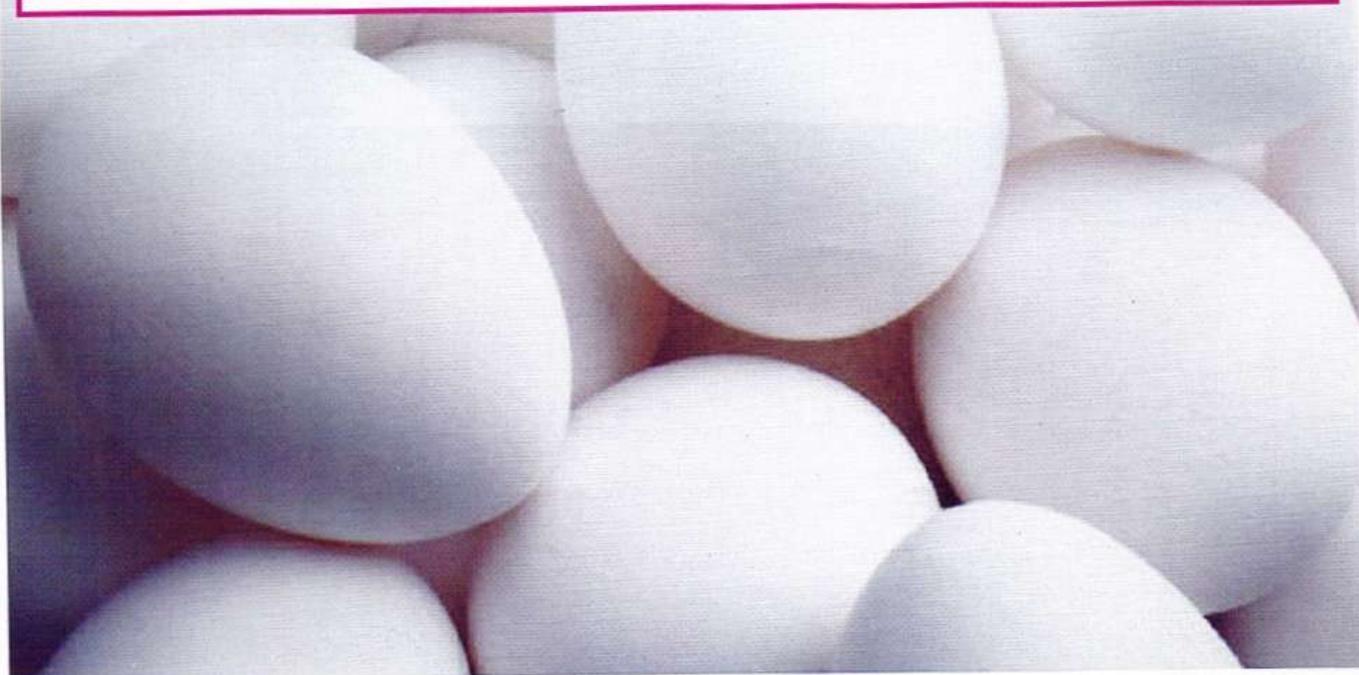
Production Characteristics

Maturity	First egg	17 to 18 weeks
	50% production	150 days
	Peak production	26 to 28 weeks
Livability	Growing	96%
	Laying	94%
Egg production	Peak	92%
	Hen housed to 72 weeks	More than 298 eggs
	Hen day to 72 weeks	More than 301 eggs
Feed consumption	Per dozen of eggs	1.77 kg
	Per kg of egg mass	2.57 kg
Egg size	Average egg weight	57 g
Egg quality	Internal	Excellent internal quality
Temperament		Easy to handle, performs well under a variety of management system



Special Features

- Efficient feed conversion
- Superiority over other stocks
- High positive return over feed cost
- Low laying house mortality





Commercial Brown Egg Laying Chicken

CARI SONALI

To cater to the needs and high demand of the consumers, this golden brown eggger was developed and released for its commercial exploitation in the year 1992 using White Leghorn as male line and Rhole Island Red as female line.

Production Characteristics

Maturity	First egg	18 to 19 weeks
	50% production	155 days
	Peak production	27 to 29 weeks
Livability	Growing	96%
	Laying	94%
Egg production	Peak	90%
	Hen housed to 72 weeks	More than 280 eggs
	Hen day to 72 weeks	More than 283 eggs
Feed consumption	Per dozen of eggs	2.3 kg
	Per kg of egg mass	3.8 kg
Egg size	Average egg weight	54 g
Egg quality	Internal	Excellent internal quality
Temperament		Easy to handle, performs well under a variety of management system



Special Features

- Lays brown eggs
- Efficient feed conversion
- High egg production





Dual Purpose Chicken

CARI DEBENDRA

CARI Debendra is a medium-sized dual-purpose bird, produced by crossing coloured synthetic broiler line as male line and Rhode Island Red as female line. It is the most suitable bird for the Indian consumers due to its attractive bright plumage colour. The bird achieves moderate body weight at eight weeks of age with economic feed conversion ratio. The meat has lower carcass and abdominal fat than broiler meat, which makes it a consumer's delight. CARI Debendra is also a suitable bird for rural poultry because of its better survivability and moderate egg production ability.

Production Characteristics

Body weight at 8 weeks	1100-1200 g
Body weight at 10 weeks	1400 to 1500 g
Body weight at 12 weeks	1700 to 1800 g
Feed conversion ratio (0-8 week)	2.5-2.6
Age at sexual maturity	155 - 160 days
Annual egg production	190-200
Livability (Growing)	97%
Livability (Laying)	94%



Special Features

- Efficient feed conversion
- Superiority over other stocks
- High positive return over feed cost
- Low laying house mortality





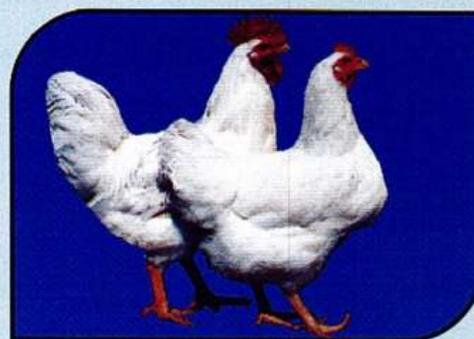
Commercial Broiler Chicken

CARIBRO VISHAL (White Broiler)

Development of suitable high yielding broiler stocks, entirely different from imported commercial broiler stocks available in the market, has been the endeavour of the Institute. Consequently, CARIBRO Vishal, a broiler that excels in the important areas of economic growth, feed efficiency, livability, meat quality and also the plumage colour with high performance features in tropical climate has been developed.

Production Characteristics

Body weight at day old	43 g
Body weight at 6 weeks	1650 to 1700 g
Body weight at 7 weeks	2000 to 2150 g
Dressing percentage	75-80
Livability percentage	97-98
Feed conversion ratio at 6 weeks	1.85



Special Features

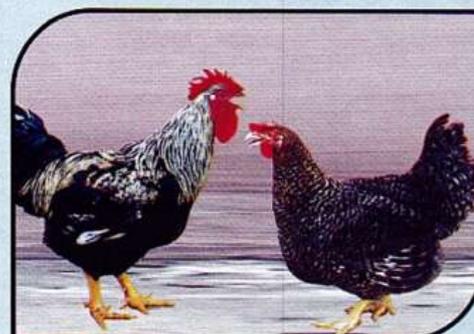
- Superior growth rate
- High disease resistance
- Excellent feed conversion
- Low production cost
- Suitable to Indian climatic and managemental conditions

CARIBRO DHANRAJA (Coloured Broiler)

CARIBRO Dhanraja is a commercial cross produced by crossing coloured synthetic male and female lines. This stock is characterized by its bright plumage colour with single comb. It is also less susceptible to adverse environmental conditions. CARIBRO Dhanraja is the most preferred bird among farmers because of its multicoloured plumage and high economic returns.

Production Characteristics

Body weight at day old	46 g
Body weight at 6 weeks	1500 to 1700 g
Body weight at 7 weeks	2000 to 2125 g
Dressing percentage at 6 weeks	73-75
Livability percentage at 6 weeks	96-98
Feed conversion ratio at 7 weeks	1.92



Special Features

- Multicoloured and hardy
- Efficient feed conversion
- Optimum dressed carcass yield



CARIBRO MRITYUNJAY (For Hot and Dry Region)

CARIBRO Mrityunjay is a commercial cross produced through introgression of naked neck gene into coloured and white synthetic broiler lines by repeated backcrossing. Both coloured and white plumage stocks of CARIBRO Mrityunjay are available. The stock is characterized by its adaptability to high ambient temperature, which make it the ideal bird for tropical environment.

Production Characteristics

Body weight at day old	38-42 g
Body weight at 6 weeks	1400 to 1500 g
Body weight at 7 weeks	1800 to 2000 g
Dressing percentage at 6 weeks	75-77
Livability percentage at 6 weeks	97-98
Feed conversion ratio at 6 weeks	1.95



Special Features

- Both coloured as well as white
- Adaptable to high ambient temperatures
- Efficient feed conversion

CARIBRO TROPICANA (For Hot and Humid Region)

Two broiler stocks one each with naked and frizzle gene were developed by introgressing these genes from desi fowl to broiler stocks by conventional crossing. These naked neck and frizzle broiler stocks were crossed to develop CARIBRO Tropicana which has both naked neck and frizzle phenotype.

Production Characteristics

Body weight at 6 weeks	1300 g
Body weight at 7 weeks	1800 g
Feed conversion ratio at 6 weeks	1.90
Feed conversion ratio at 7 weeks	2.11
Dressing percentage at 7 weeks	74
Livability percentage at 7 weeks	97



Special Features

- Better heat tolerant
- Better dressing percentage
- Perform better with low inputs under hot and humid conditions
- Better option for tropical poultry production



Improved Indigenous Fowl

Four types of high yielding germ-plasm suitable for backyard poultry production have been developed with native fowl base especially suitable for different climatic regions of the country. These birds have combination of 50% native and 50% exotic blood and possess other characteristics essential for backyard/scavenging poultry production. Phenotypically these birds look like their original native breed with two or three times more egg production with bigger size and weight, better tropical adaptability and disease resistance along with capability of bearing the stress of sub-optimal feeding and management.

CARI NIRBHEEK

It is a cross of Indian native breed Aseel with CARI Red. Birds are active, large in built, pugnacious in nature with high stamina and majestic gait. They are able to save themselves from their predators due to their fighting characters and activeness and are adapted to all climatic zones of the country.

Production Characteristics

Body weight at 20 weeks (Males)	1847 g
Body weight at 20 weeks (Females)	1350 g
Age at sexual maturity	176 days
Annual egg production	198
Egg weight at 40 weeks	54 g
Fertility	88%
Hatchability (FES)	81%



CARI SHYAMA

It is a cross of Kadakanath breed of Indian native chicken with CARI Red. Birds have plumage of various colours dominated by black. The skin, beak, shank, toes and soles are dark gray colour. The peculiarity of this bird is that most of the internal organs show the characteristic black pigmentation. Varying degree of blackish colouration is also found in skeletal muscles, tendons, nerves, meninges, brain and bone marrow. The black colour of muscles and tissues is due to deposition of melanin pigment which causes increase in protein and decrease of fat and muscle fiber length. This variety is ideally suited for rearing in tribal areas due to preference for dark meat by the tribal population.

Production Characteristics

Body weight at 20 weeks (Males)	1460 g
Body weight at 20 weeks (Females)	1120 g
Age at sexual maturity	170 days
Annual egg production	210
Egg weight at 40 weeks	53 g
Fertility	85%
Hatchability (FES)	82%





UPKARI

Indian native chicken with Frizzle plumage has been crossed with CARI Red for development of Upcari birds. These multicoloured birds have single comb and medium body size. Presence of Frizzle plumage helps in fast heat dissipation due to which birds are better adapted to tropical climate specially for arid zones.

Production Characteristics

Body weight at 20 weeks (Males)	1688 g
Body weight at 20 weeks (Females)	1285 g
Age at sexual maturity	165 days
Annual egg production	220
Egg weight at 40 weeks	60 g
Fertility	90%
Hatchability (FES)	84%



HITCARI

Hitcari birds have been developed by crossing the Indian native Naked neck with exotic breed CARI Red. The neck region is devoid of feathers and there is reduction of 30 to 40% feathers on the body. The reduction in feathers help in internal heat dissipation which increases the tropical adaptability due to which there is no reduction in egg production and egg shell thickness during extreme summer. There is a decrease in heat stress mortality, increase in fertility and hatchability during summer and protein requirement for juvenile growth is reduced. These birds are very suitable for rearing in the hot humid coastal region.

Production Characteristics

Body weight at 20 weeks (Males)	1756 g
Body weight at 20 weeks (Females)	1320 g
Age at sexual maturity	178 days
Annual egg production	200
Egg weight at 40 weeks	61 g
Fertility	92%
Hatchability (FES)	81%





Improved Guinea Fowl Varieties

The Guncari birds were developed through selection and breeding programme from a wide base stock of indigenous Guinea fowl. These birds are improved for high disease resistance and better growth rate. Three varieties of Guncari birds viz. Kadambari, Chitambari and Swetambari are available for commercial utilization. It is a hardy bird, suitable for any agro-climatic condition. There is no requirement of elaborate and expensive housing. It has excellent foraging capabilities and consumes all non-conventional feed not used in chicken feeding. It is more tolerant to mycotoxins. The hard egg shell provides minimum breakage and long keeping quality. Guinea fowl meat is rich in vitamins and low in cholesterol.

KADAMBARI

Production Characteristics

Body weight at 8 weeks	500-550 g
Body weight at 12 weeks	950- 1000 g
Age at first egg	230-250 day
Egg weight	38-40 g
Egg production (March to September)	100-120 eggs
Fertility	70-73%
Hatchability on fertile eggs set	70-78%
Livability	Excellent



Special Features

- Kadambari has black plumage with white and uniformly distributed spot.





CHITAMBARI

Production Characteristics

Body weight at 8 weeks	500-540 g
Body weight at 12 weeks	970- 1000 g
Age at first egg	232-251 day
Egg weight	38-40 g
Egg production (March to September)	105-125 eggs
Fertility	70-73%
Hatchability on fertile eggs set	70-78%
Livability	Excellent



Special Features

- Chitambari has white spot on gray plumage.

SWETAMBARI

Production Characteristics

Body weight at 8 weeks	500-525 g
Body weight at 12 weeks	920- 980 g
Age at first egg	230-250 day
Egg weight	38-40 g
Egg production (March to September)	100-115 eggs
Fertility	70-75%
Hatchability on fertile eggs set	70-80%
Livability	Excellent



Special Features

- Swetambari is pure white in colour.



Improved Quail Varieties

Japanese quail (*Coturnix coturnix japonica*) has created a huge impact in poultry sector and many quail farms have been established recently throughout the country, both for egg and meat production. CARI has been a nerve centre for introduction, genetic improvement and developing quail production technology in India since 1974. Through concerted efforts, a workable package of feeding, management and health care practices have been developed to support quail production in a scientific manner. This Institute has been maintaining pure lines of quail (broiler and layer types), and their consistent supply to both public and private sectors in the country for commercial exploitation.

CARI UTTAM (Broiler Quail)

Production Characteristics

Body weight (4 th week)	150-155 g
Body weight (5 th week)	240 g
Feed efficiency (4 th week)	2.51
Feed efficiency (5 th week)	2.60
Daily feed consumption	25-28 g
Hatchability on total egg set	70-75%



Special Features

Better livability, body weight gain, feed conversion and profit

CARI PEARL (White Egger)

Production Characteristics

Body weight (5 th week)	140 g
Daily feed consumption	20-25 g
Age at 50% egg production	8 weeks
Age at 80% egg production	10 weeks
Hen day production	<u>285-295</u> eggs
Hatchability on total egg set	70-80%



Special Features

High egg production and egg also ideal for biological research



CARI UJJAWAL (White Breasted Quail)

Production Characteristics

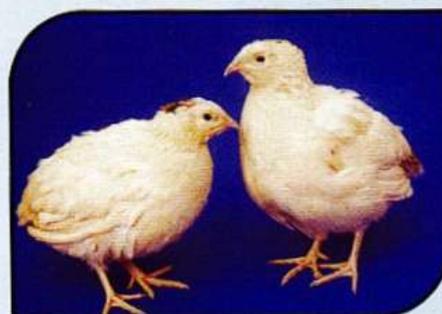
Body weight (4 th week)	140 g
Body weight (5 th week)	175 g
Feed efficiency (5 th week)	2.80 M
Daily feed consumption	25-28 g
Hatchability on total egg set	65%



CARI SWETA (White Feathered Quail)

Production Characteristics

Body weight (4 th week)	135 g
Body weight (5 th week)	155-165 g
Daily feed consumption	25 g
Feed efficiency (4 th week)	2.60 M
Feed efficiency (5 th week)	2.70
Hatchability on total egg set	50-60%



CARI BROWN (Brown Feathered Quail)

Production Characteristics

Age at sexual maturity	38-41 days
Body weight (4 th week)	148-160 g
Body weight (5 th week)	180-185 g M
Hatchability on total egg set	60-65%
Plumage colour	Completely brown



CARI SUNHERI (Brown Feather White Breasted)

Production Characteristics

Age at sexual maturity	43 days
5 th Week body weight (straight-run)	182 g M
Feed conversion ratio (5 th week)	2.8
Average egg weight	11 g
Age at 50% egg production	8 weeks
Age at peak egg production	12-13 weeks
Livability (0-5 weeks of age)	95%
Hatchability on total egg set	68%





Improved Turkey Varieties

CARI Virat (Turkey mixed) is mainly reared for meat. It is one of the choicest white meat known for its leanness. It is a popular delicacy especially for festive occasions like X'mas and New Year. Turkey meat has tremendous commercial viability because of its low fat and cholesterol contents. It is quite suitable for upliftment of small and marginal farmers. Turkey can be easily reared in free range or semi-intensive system with minimal investment for housing, equipments and management.

CARI VIRAT

Production Characteristics

Age (week)	Body weight (g)	Feed Conversion Ratio
6	1054	1.85
8	1748	2.05
10	2101	2.37
12	2778	2.80
24	5270	3.78
32	7100	4.15
Fertility		94%
Hatchability		86%



Special Features

- Low fat
- Low cholesterol
- Choicest white meat
- Suitable for backyard rearing





Ducks

MOTI (Native Meat Type)

Production Characteristics

Body weight at 6 th week	1300 g
Mature body weight	Male 3300 g; Female 2100 g
Age at sexual maturity	30-35 weeks
Egg production	50-60 eggs/year
Egg weight	60-70 g
FCR at 6 weeks	2.75



KUZI (Native Egg Type)

Production Characteristics

Body weight at 6 th weeks	950 g
Mature body weight	Male 1500 g, Female 1200 g
Age at sexual maturity	18-20 weeks
Egg production	220-230 eggs/year
Egg weight	65-70 g
FCR at 6 weeks	3.28



KHAKI CAMPBELL (Exotic Egg Type)

Production Characteristics

Body weight at 6 th week	1050 g
Mature body weight	Male 1600 g; Female 1350 g
Age at sexual maturity	19-20 weeks
Egg production	240-260 eggs/year
Egg weight	60-68 g



WHITE PEKIN (Exotic Meat Type)

Production Characteristics

Body weight at 6 th week	1850 g
Mature body weight	Male 2900 g, Female 2500 g
Age at sexual maturity	22-24 weeks
Egg production	150-180 eggs/year
Egg weight	75-85 g
FCR at 6 weeks	2.10





Avian Biotechnology

DEVELOPMENT OF TRANSGENIC SPERMATOZOA

Chicken may be an excellent model to be used as bioreactor to produce proteins of pharmaceutical importance through transgenesis. The multi-cellular stage of embryo in freshly laid egg, breaking of the eggshell to get access to embryo and the presence of large amount of yolk are certain hurdles in developing transgenic chicken, unlike in mammals. However, sperm mediated gene transfer method may be the method of choice for transgenic chicken production and developing transgenic sperm is first crucial prerequisite.

A simple method of integrating the foreign DNA into spermatozoa genome has been developed and optimized. Protocol briefly includes separation of spermatozoa from semen through centrifugation, washing of spermatozoa with washing buffer and its subsequent dilution of spermatozoa in a fixed concentration in a suitable buffer. A foreign DNA (gene to be integrated) plus liposome mixture is prepared by mixing them in certain proportion and incubation at room temperature. Similarly, a restriction enzyme (*NcoI*) and liposome mixture is prepared by mixing both in a fixed concentration and room temperature incubation. Subsequently, both the mixtures are mixed and resultant admixture is incubated for a fixed duration at room temperature. It can be used to inseminate the hens.

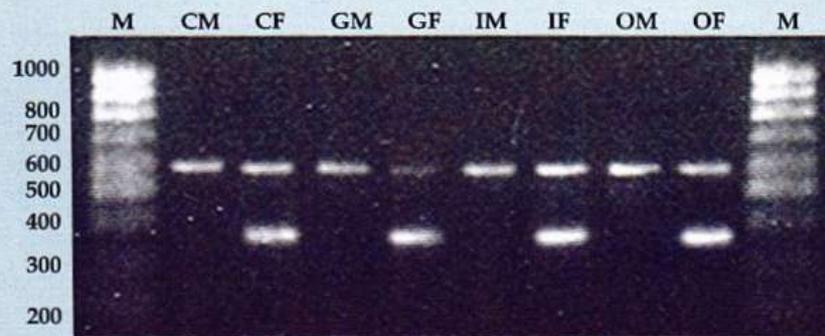
ESTIMATION OF PARENTAL GENOMIC PROPORTION IN PROGENIES USING MICROSATELLITE MARKERS

Offsprings receive half of the genome from each parent i.e., 50% from dam and 50% from sire. Since, the DNA markers are the part of genome, hence the offspring inherit these markers also as a part of genome and the markers come from father as well as mother side. Hence, the proportion of a particular parent in offspring can be judged from the proportion of the markers in the offspring, specific to that particular parent and this proportion of markers may be expressed as proportion of common band sharing between the parent(s) and offsprings, which will in turn, reflect the genetic similarity between them.

The basic protocol includes identification of polymorphic microsatellite markers, isolation of genomic DNA from the parent(s) and offsprings to make a panel of genomic DNAs; PCR amplifications using this panel of genomic DNAs for each microsatellite markers, resolution on metaphor agarose, sizing of the alleles and estimation of proportion of the common alleles at each markers as well as cumulatively on all markers. This cumulative proportion of common bands will show the genetic similarity between parent(s) and offspring and may range from 0 to 1. Higher the proportion, higher will be the parental genomic proportion.

MULTIPLEX PCR FOR SEX DIFFERENTIATION IN GUINEA FOWL

In avians, females are the heterogametic sex (ZW) while males are the homogametic sex (ZZ). Hence, the W chromosome specific sequences/genes may provide an effective way for sex differentiation using PCR based methods. Major problem faced with W chromosome specific sequence based PCR methods is to differentiate between the no amplification in males with PCR failure. Hence to amplify a common band in both the sexes and female specific band only in female simultaneously is the best method to overcome this problem. Thus, using a set of primers



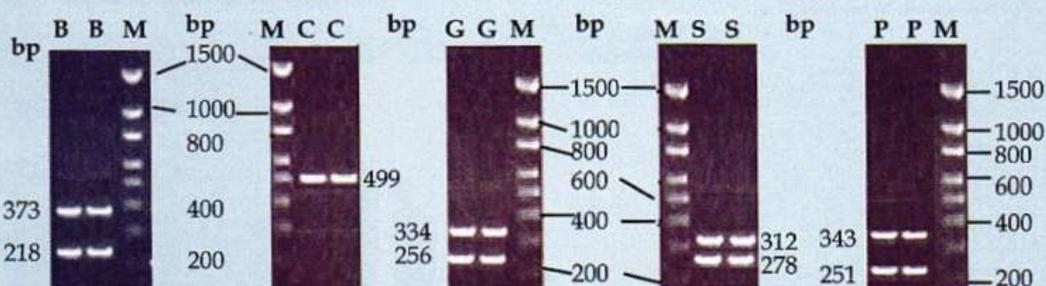
Amplification of two bands i.e. 370 bp and 590 bp in females and one band i.e. 590 bp in males.
 CM : Chicken male, CF : Chicken female, GM : Guinea Fowl male, GF : Guinea Fowl female
 QM : Quail male, QF : Quail female, TM : Turkey male and TF : Turkey female;
 M: Molecular size marker-100bp DNA ladder

i.e., USP1 and USP3 specific to W Chromosome 0.6 kb EcoRI fragment, hence specific to females and another set of primers i.e., DS1 and DS2, specific to partial 16S rRNA gene, hence common to both, a multiplex PCR was developed. In guinea fowl, female will show 2 bands i.e., 370 bp female specific and 590 bp common bands, while males will show only 590 bp band. This method will be used in sex differentiation in guinea fowl at day old age, as sexual bi-morphism is very poorly defined in this species

PCR-RFLP BASED MEAT SPECIATION

Meat adulteration is a serious offence and becomes more serious when religious taboos are added to it. Among the various methods used for identification of the origin of meat, the DNA based methods are more reliable. Among DNA based methods, meat speciation based on mitochondrial DNA sequences are more advantageous due to designing of universal primers, availability of comparatively good amount of DNA even from very small/processed/rotten meat samples.

Common name	Restriction enzyme	Expected size of restriction fragment
Buffalo	Dsre-I	219, 372
Cattle	Dsre-II	90, 499
Goat	Dsre-III	256, 334
Sheep	Dsre-IV	312, 278
Pig	Dsre-V	343, 251



RE profile of selective 16S rRNA fragment amplified from the genomic DNA extracted from the buffalo meat with Dsre-I, cattle meat with Dsre-II, goat meat with Dsre-III, sheep meat with Dsre-IV and pig meat with Dsre-V restriction enzymes. B : Buffalo, C : Cattle, G : Goat, S : Sheep, P : Pig, M : 100 bp-1500 bp DNA ladder



Basic protocol includes the isolation of genomic DNA from meat sample(s), amplification of the common band and its subsequent digestion with all the identified species specific restriction enzymes. The meat species are identified on the basis of restriction enzyme profile specific to that species. The universal primers capable of amplifying ~ 590 bp partial mt 16S rRNA fragment are developed.

DEVELOPMENT OF SELECTION CRITERIA FOR ENHANCED IMMUNOCOMPETENCE

Enhancing immunocompetence of the birds without compromising production is a challenging task. The modified genetic selection procedures for enhancing the immunocompetence in chicken without compromising the production were standardized and developed for application in breeding operations. Both humoral and cell mediated response parameters were increased in successive generations without losing body weight in broiler chicken lines divergently selected for immunological parameters.

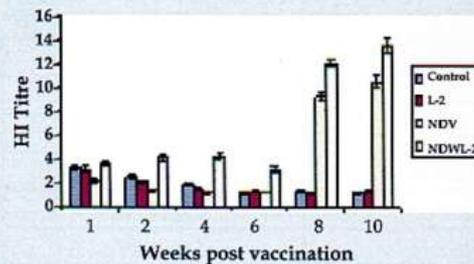
RECOMBINANT CYTOKINES PRODUCTION AND THEIR USE AS ADJUVANT AND GROWTH PROMOTER

Cytokines offer a class of proteins substances that can be used in recombinant form as safe and naturally occurring immunoadjuvant, immunodulator and growth promoter.

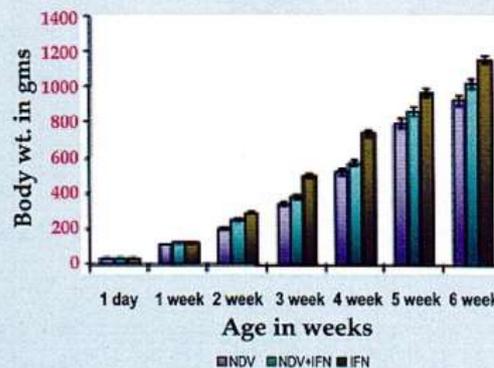
Poultry cytokines namely, IFN- γ , IL-2, Lymphotactin and CCLi4 (RANTES) were produced in prokaryotic expression system. Use of recombinant IL-2 resulted into higher responses to ND vaccine and that of IFN- γ led to higher humoral and CMI responses to ND vaccine as well as higher body weights in broiler chicks. Procedures for production and application of recombinant cytokines of poultry were evaluated and standardized.



Polyacrylamide gel showing expression of recombinant cytokines



Assessment of adjuvant property of rChIL-2 with ND



Assessment of growth promoter property of rChIFN- γ in broilers

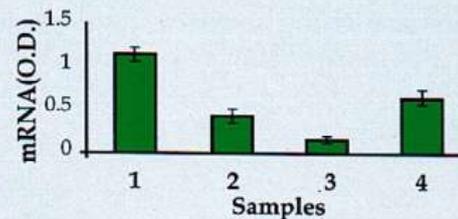
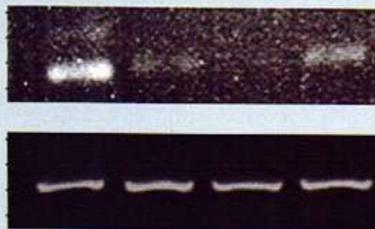


MOLECULAR MARKER FOR IMMUNE RESPONSE TO NEWCASTLE DISEASE VIRUS (NDV)

Identification of molecular marker for enhancing protection against specific disease has been a constant pursuit of poultry geneticist. The SNP (A318G) in IFN- γ promoter region was found to be associated with immune response to NDV. Allele -318G was identified as molecular marker for improving immune response to NDV. A simple procedure applicable in commercial breeding programme without hi-tech laboratory facilities for increasing the frequency of -318G allele in population and thereby improving the ND vaccine response was developed.

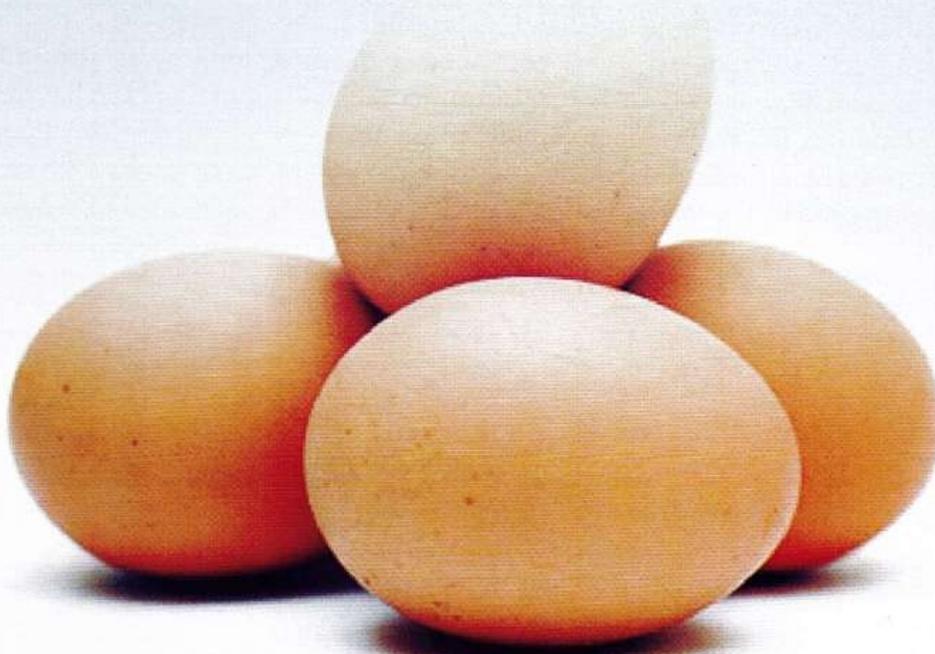
SILENCING OF MYOSTATIN GENE IN CULTURED CHICKEN EMBRYO FIBROBLAST

The biotechnological tools are envisaged to have the potential to overcome physiological barriers for increasing muscle development. The application of RNAi for silencing myostatin gene was a step forward in this direction. siRNAs for myostatin were designed and procedures were developed for silencing myostatin gene in cultured chicken embryo fibroblast.



1. GMEM Control
2. siPORT lipid Control
3. siPORT lipid + siRNA(2)
4. siPORT™ Amine + siRNA(2)

Estimation of myostatin expression in cultured CEF in siRNA experiment

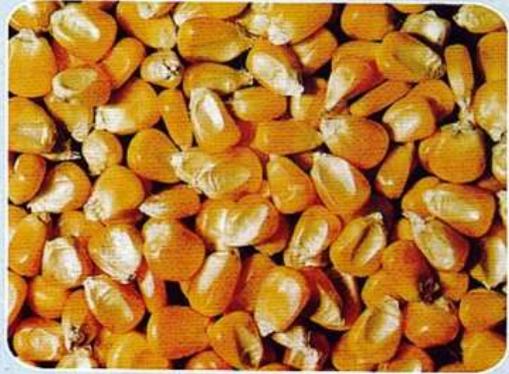




Feeding and Feed Resources

UPDATING NUTRIENT REQUIREMENTS

The requirements and bioavailability of dietary nutrients e.g. protein, energy, amino acids, certain minerals and vitamins for different classes of poultry such as meat and egg type chicken, quails, guinea fowl, turkey etc. are being updated regularly with the change in genetic potential of birds. The dietary interrelationships of energy and protein; lysine and methionine; vitamin D₃, calcium and phosphorus; zinc and manganese; selenium and vitamin E, lysine, folic acid and biotin etc. have been established. It has been feasible to reduce dietary protein requirements of growing chicks, layers, broilers and



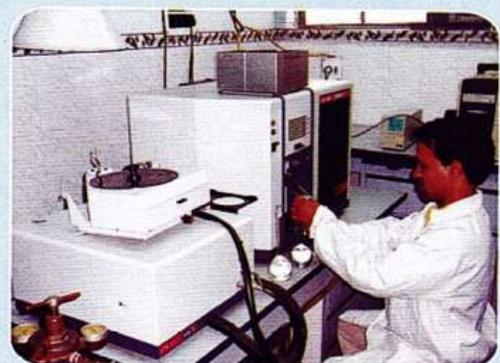
quails and to improve nitrogen utilization efficiency through precise supply of critical amino acids. The comparative efficacy of DL-methionine and methionine hydroxyl analogue has been established in the diet of broiler chickens and quails. The requirements for broilers and growing and laying quails have been successfully partitioned for developing feeding standards. These recommendations are being used by poultry farmers, feed manufacturers, researchers and Bureau of Indian Standards (BIS).

ALTERNATE FEED RESOURCES

India, due to its highly variable landscape and agro-climate, produces large number of raw materials for feeding. The database of nutritive and feeding value of alternate feed resources such as sunflower seed meal, maize gluten meal, rapeseed/mustard oil meal, rice bran, wheat bran, guar meal, cotton seed meal, tapioca, sunflower cake, niger meal, millets, molasses, apple pomace, broken rice, neem seed kernel, etc. have been developed. Besides this, low cost feed formulae have successfully been developed for various poultry by incorporating alternate feed resources such as nutritious cereals and agro-industrial by-products. Several ingredients in the category of nutritious cereals such as sorghum, pearl millet, finger millet, small millets and rice *kani* and residues such as rapeseed meal, cotton seed meal, sesame meal, groundnut meal, sunflower seed meal, safflower seed meal, toasted guar meal and niger meal etc. have been tested alone or in combination for their effective utilization in poultry rations. The low cost feed formulae thus developed were tested through on farm trials at farmers' doors with encouraging results and are being used by the farmers and for updating MakeFeed Poultry software.

APPLICATION OF BIOTECHNOLOGY AND FEED ADDITIVES

The nutritive value of feedstuffs has been augmented through various physical, chemical and biological treatments like water washing, wet processing (reconstitution with or without enzymes), dry processing (acidified sodium chlorite treatment for feed hygiene), roasting, autoclaving, alkali and acid treatments, fungal treatment and fermentation of the feed ingredients.





Addition of microbial phytase in diets of broiler chicks, egg type chickens, guinea fowl and quails improved phosphorus utilization significantly that provided scope to reduce costlier di-calcium phosphate supplementation. Enzyme supplementation was also found beneficial to improve utilization of sunflower seed meal, maize- finger millet or maize-sorghum based broiler starting and finishing diets. The solid substrate fermentation technique using *Pleurotus sajarcaju* improved the nutritive value of quail droppings. Similarly, using *Aspergillus niger* improved the nutritive value of toasted guar meal. The role of dietary supplementation of mineral chelates, prebiotics and probiotics, organic acids, feed sanitizers in enhancing the performance and immune response of poultry has also been established. The safety aspects and feeding value of various genetically engineered crops (Bt cotton, Bt brinjal and quality protein maize) have also been established.

DETECTION AND AMELIORATION OF ANTI-NUTRITIONAL FACTORS

Implications of anti-nutritional factors, fungal toxicants and pesticide residues in various feeds and their effective amelioration remedies in the processes of safe food production have been explored. The tolerance levels of dietary aflatoxins in various types of chicken were determined as follows:

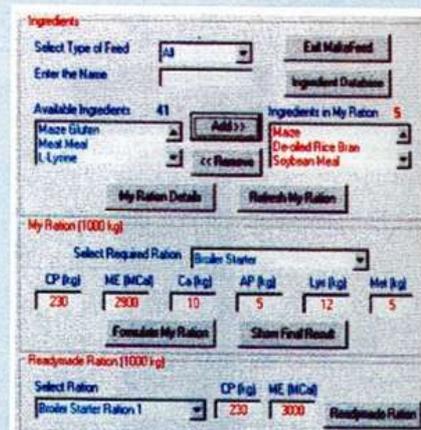
White Leghorn chicks	:	150 ppb	Purebred broiler chicks	:	200 ppb
Crossbred broiler chicks	:	400 ppb	Quail starter chicks	:	300 ppb
Quail layers	:	300 ppb	Guinea fowl keets	:	1500 ppb

Increasing dietary protein, addition of methionine or choline, vegetable oil (with enhanced levels of vitamin E and choline), activated charcoal, hydrated sodium calcium alumino silicate (HSCAS), BHA and selenium were found to alleviate the toxicity of aflatoxins.

The tolerance levels of dietary fenvalerate (FEN) and methyl- parathion (MPA) were established as 50 and 20 ppm in the diet of broilers. Activated charcoal (0.25%) was able to avert the toxicity of 100 ppm FEN in broilers and partially effective in protecting performance of broilers against 25 ppm MPA in diet. Supplementation of TOXORB @ 2 g/kg in diet containing 50 ppm fenvalerate and 25 ppm methyl-parathion insecticide was found effective in averting the adverse effect of these insecticides in broiler chickens. The supplementation of TOXORB was found to be beneficial in averting the adverse effect of fenvalerate and methyl-parathion insecticides in quail chicks.

COMPUTER SOFTWARES FOR FEED FORMULATION

MakeFeed Poultry and *MakeFeed Dairy*, comprehensive feed formulation softwares, developed by combining the expertise, knowledge and standards of recent technologies are very useful for poultry and dairy entrepreneurs. These are window based unique softwares for efficient balanced formulation of feed for a wide variety of poultry birds like layer and broiler chickens, quails, guinea fowls etc. and dairy animals like cattle and buffaloes for maximum production performance. *MakeFeed* is a user-friendly and persons having little computer knowledge can utilize it effectively. It provides information on nutritive values for a wide range of feed ingredients along with the maximum inclusion level for each ingredient. The users have





options to edit the complete database of feed ingredients and modify suitably, add or delete particular feed ingredient due to change in nutritive composition and availability of feed ingredients.

The cost of the software package is Rs. 1500/- only for *MakeFeed Poultry* and Rs. 2000/- for *MakeFeed Dairy*, which includes the compact disc containing the software and a comprehensive user manual. Those who want to receive the softwares by post, please remit Rs. 100/- extra towards the processing, handling and postal charges.

QUALITY ASSURANCE AND ANALYSIS OF FEEDS AND FEEDSTUFFS

The Nutrition Division is equipped with well furnished laboratories with modern equipments. Various feed ingredients and compounded feed/concentrates received from the industry, government agencies and farmers are being examined for proximate principles, minerals, adulterants and toxicants.

Rates for feed analysis

Sl. No.	Tests	Rate/test (Rs.)
1.	Moisture	20/-
2.	Crude protein	50/-
3.	Crude fibre	50/-
4.	Ether extract	50/-
5.	Total ash	50/-
6.	Acid insoluble ash (Sand and silica)	80/-
7.	Calcium	50/-
8.	Total phosphorus	50/-
9.	Complete analysis (Sl. No. 1 to 8)	350/-
10.	Gross energy	50/-
11.	Common salt (sodium chloride)	50/-
12.	Non-protein nitrogen	100/-
13.	Urease activity	150/-
14.	Tannins	150/-
15.	Glucosinolates	150/-
16.	Aflatoxin	150/-
17.	Zinc	100/-
18.	Manganese	100/-
19.	Iron	100/-
20.	Copper	100/-

- The analysis report is made available within a week from the date of receipt of the feed sample along with demand draft.
- Minimum amount of 100 g of feed sample is to be sent in sealed cover.
- If analysis report is required to be sent through Speed Post/Courier, an additional amount of Rs. 50/- may be added. Reports can also be sent through fax or e-mail.
- The analysis report is not valid for legal purpose.



DIETARY MODULATION FOR DESIGNER EGGS AND MEAT

Poultry meat and eggs have already gained a healthy image, which are further being designed to perform a particular function or set of functions effectively and reliably to suit the specific purpose as per the needs of the consumers. Supplementation of guggul (*Commiphora mukul*), alone or in combination with arjuna (*Terminalia arjuna*), cinnamon (*Cinnamomum verum*) and amla (*Emblica officinalis*) in hens diets resulted in reduction of yolk cholesterol by 19.5% and 18.2%, respectively from 6th week onwards. Supplementation of 125 mg Cu/kg diet as copper sulphate proved effective in reducing the egg yolk cholesterol content by 18%, while 24% by supplementing layer ration with 300 mg Cu/kg together with 3200 µg chromium per kg diet. The supplementation of Atorvastatin 0.03% + Niacin 375 ppm + ethylene diamine-tetra acetic acid (EDTA) 0.5% in diet of laying hens reduced egg yolk cholesterol content up to 35%. Addition of fish oil or spirulina also enriched omega-3 fatty acids in eggs.

Naturally occurring antioxidant-vitamin E or alfa-tocopherol has been reported to be effective in improving self-life of poultry meat and meat products through delaying lipid oxidation. Dietary supplementation of vitamin E @ 300 mg/kg diet during last 10 days or 150 mg/kg diet during last three weeks of age (3-6 weeks of age) improved self-life of poultry meat before slaughter. The role of dietary selenium (Se) in influencing the poultry meat quality has also been established. Supplementation of prebiotics (mannan-oligosaccharides) and probiotics (*Bacillus subtilis*) in diet improved microbiological meat quality.





Physiological Approaches to Augment Poultry Production

A NEW SELECTION PARAMETER FOR IMPROVEMENT OF EGG NUMBER AND SIZE

The search of fastest method to improve both egg number and size is the basic need of the poultry breeder. This new approach is likely to speed up the process of selection. It is revealed through exhaustive in depth research that LH receptor cascade maturation rate determines the laying intensity and it has got a strong association with rapid phase of yolk deposition, which is easily monitor able parameter. This phase varies in hens from 5-11 days. Shortest is the duration of maturation largest is the laying intensity. This determination work on the fact that liver synthesizes the yolk, enters in circulation and around the time exogenous fat-soluble black dye either administered through feed or intra venous injection absorbed in the lipid component of yolk and then transferred to growing follicles as indicator. The presence of black colour at the periphery and centre of the laid eggs is considered to determine the duration of rapid phase. Further, the major difference in deposition of yolk take place in last 24 to 48 hr. The yolk size determines the egg size. Hence shortest phase with maximum yolk deposition in preceding 24/ 48 hours to ovulation can be used to identify the hens having best laying intensity with optimum egg size within fortnight instead of recording the eggs up to part year or full year production. This parameter is recommended for evaluating the genetic laying potential of a hen within fortnight instead of part year (40 weeks of age) or full year recording of eggs for selection purpose. It allows better screening of female at initial phase of laying itself.

A NEW AND SIMPLE DILUENT FOR CHICKEN SEMEN

The ultimate goal of a diluent is to improve the reproductive efficiency of male birds and to reduce the cost of poultry production by employing the technique of artificial insemination. Diluted semen can be inseminated into more numbers of hens, which is not possible by undiluted semen. A major portion of the freshly ejaculated undiluted spermatozoa starts to lose their integrity just after collection of semen from male. Therefore, to obtain the best fertility by artificial insemination it is necessary to have a suitable simple diluent for chicken semen. Commonly available extenders are complex in their composition and need adjustment of pH resulting in more preparation time and are also very expensive. Due to these problems, such dilutors are not feasible under field conditions. Keeping in view the above facts, a new and simple diluent has been prepared for successful preservation of chicken semen at low temperature for 24 hr. This diluent is simple, requires minimum ingredients and no adjustment of pH because the composition of the diluent is prepared in such a way that the desired pH (7.3) and osmotic pressure (375 m. Osm/kg H₂O) can be achieved automatically. This simple chicken semen diluent can express very good fertility even after 24 hr of storage at low temperature under test conditions.

FERTILITY PREDICTION TEST FOR MALE JAPANESE QUAIL

There is problem of semen collection in male Japanese quail due to low volume of semen and presence of foam in cloacal gland. Maringue-like foam is produced from the cloacal gland of sexually active male Japanese quail which is unique among the avian species. Therefore, due to the presence of foam in cloacal gland semen gets mixed with the foam at the time of semen collection which makes semen examination in quail very difficult.

Therefore, CARI, Izatnagar has developed an indirect method for the evaluation of the fertilizing ability of the bird based on the size of cloacal gland and colour of foam produced by the cloacal



gland. Males with high fertility rate produce large amount of normal white foam whereas, birds with poor fertility status donate either less foam or yellow to brown colour of foam. In addition, smaller sizes of cloacal gland remained associated prominently with the infertility of birds as compared to those birds possessing large size of cloacal gland. This test is simple, cost-effective and can enhance fertility in quails up to 12%.

SIMPLE ASSAY FOR DETERMINATION OF NITRIC OXIDE IN BIOLOGICAL SAMPLES

Nitric oxide plays a significant role in neurotransmission, critical reproductive functions like ovulation and host defense against invading microorganisms. Several other critical functions of this molecule have been unveiled with the stream of research in biological systems. A simple macro and micro assay for the spectrophotometric determination of products of nitric oxide (nitrite and nitrate) was developed. Nitrite/nitrate in the biological samples can be estimated in a single step by this method. The principle of the assay is reduction of nitrate by copper cadmium alloy followed by colour development with Griess reagent (sulfanilamide and N-naphthyl ethylene diamine) in acidic medium. This assay is sensitive to $1\mu\text{M}$ nitrate and is suitable for different biological fluids including sera with a high lipid concentration. The copper-cadmium alloy used in the method is easy to prepare and can completely reduce nitrate to nitrite in an hour. The method provides a simple and cost-effective assay for the estimation of stable oxidation products of nitric oxide in the biological samples.

AN EASY TECHNIQUE FOR STUDYING INTESTINAL NUTRIENTS UPTAKE IN POULTRY

A vast range of feed ingredients and their by-products are being used in the diets of poultry. Besides, several feed supplements are also being incorporated in the diets to ensure enough feed intake, digestion and/or absorption. An easy and simple *in vivo* technique under laboratory conditions has been developed to know the uptake of certain nutrients (calcium, phosphorus, glucose etc.) through the intestine of chicken.

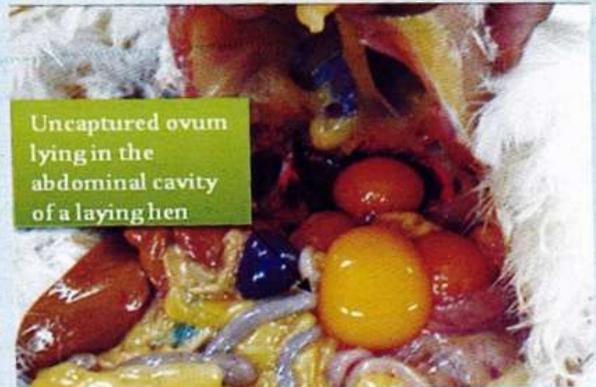
CAUSE OF INTERNAL LAYING REVEALED

Earlier studies have reported about 30% incidences of internal laying in birds during the start of lay period. Such laying anomalies may have aggravated in modern breeds particularly in broilers strains due to heavy selection pressure for rapid growth as the negative association exists between growth and reproductive traits. In view of this fact and considering the escalated cost of day old broiler chicks, the focus was set to probe the cause of such malfunction in order to tackle this vexing problem. Around the age of sexual maturity in broiler breeder hens, the egg production traits, ovarian and oviduct status, endocrine and molecular profiles has been assessed by following standard tools to reveal the cause of this reproductive anomaly.

Findings revealed a drastic escalation of internal laying over 45% in modern broiler strain. The average number of hierarchal yellow follicles and the hens with double hierarchy was found more in internal layers as compared to normal. In modern strains, it is likely that increased facilitatory recruitment of yellow follicles into growth cycle might have some role in predisposing this problem of internal laying. A main culprit for internal laying at endocrine level was noted a significant drop in $17\text{-}\beta\text{-estradiol}$: progesterone ratio against healthy normal laying birds. At



molecular level, in the infundibular tract of hens, a significant down regulation of receptors for progesterone (0.459), 17- β -estradiol (0.258) and testosterone (0.673) were recorded in internal layers as compared to normal birds. In double yolk (hierarchy) bearing hens, which were more prone to internal laying problems, a significant down regulation of progesterone (0.555), 17- β -estradiol (0.217) and testosterone (0.530) was also recorded as compared to normal laying hens. In anterior pituitary gland, no significant dereference in gene expression of receptors was observed in developmental stages of ovary or due to internal ovulation or during follicular atresia around the age of sexual maturity.



Uncaptured ovum lying in the abdominal cavity of a laying hen

In modern broiler breeding hens, the incidence of internal laying has markedly upsurged on account of alterations in sex steroids receptor system at infundibulum level probably contributing to weakened ova capturing ability. This finding has opened the way to improve the number of eggs around the age of sexual maturity and thereby to add some more day old broiler chicks.

DEVELOPMENT OF A NEW SEMEN DILUTOR FOR JAPANESE QUAIL

Japanese quail spermatozoa cannot withstand storage outside the body and die within few minutes. Quail spermatozoa are prone to agglutination in physiological solutions or diluents that are commonly used for diluting bird's semen. Therefore, attempts have been made to develop a suitable semen diluent for Japanese quail. Different existing diluents (Lake, BPSE, Tyrode's and Kim's) were initially tried as such and with some modifications for their suitability to quail semen with a limited success. A new diluent was designed for the quail semen and was evaluated with parameters like mass sperm motility, dilution rate, holding temperature, storage duration and fertility. Among the five diluents tested in terms of mass motility and dispersion of spermatozoa, the new diluent was found to be suitable for quail spermatozoa. Among all diluents tested for fertility, the new diluent found suitable for quail with 77.55% fertility. The other diluents used in this study showed 10.70 - 27.64% fertility. The motility scoring and fertility was found higher at room temperature when compared to 4°C. The new diluent performed better at 1:2 dilutions at room temperature for 30 minutes.



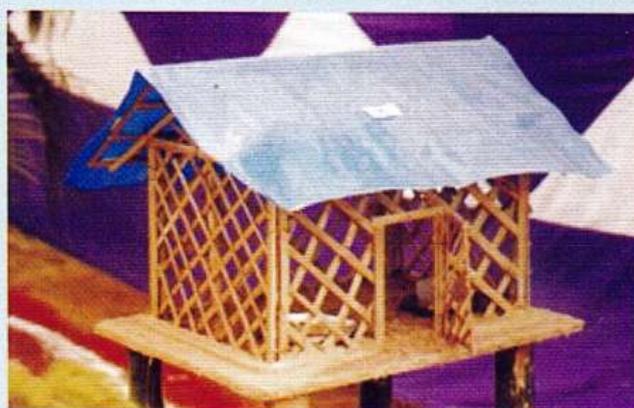
Swirling movement of quail spermatozoa in new dilutor



Shelter and Management Practices

LOW COST POULTRY HOUSES FOR SMALL SCALE RURAL POULTRY FARMING

Five different types of low cost poultry houses have been designed for housing 120 broilers or 60 layers. These houses are eco-friendly and within the reach of the poor farmers. The houses as designed are made up of bamboo and tarpoline sheet roof, terracotta tiles mud, brick and asbestos sheet roof, bamboo and plastic sheet roof, and wire net and hay roof which are approximately costing Rs. 6200/-, 4600/-, 8300/-, 6000/- and 4600/-, respectively.



CALIFORNIA COLONY CAGE FOR COMMERCIAL LAYERS

To provide better welfare and improvement in production potential California colony laying cages have been designed and fabricated having width 115 cm, depth 47 cm and height 43 cm to house 5-6 laying birds.



DESIGN AND PROTOTYPE OF QUAIL FARM APPLIANCES

In order to popularize quail farming, battery brooders, individual and colony laying cages, feederers, waterers, setters and pedigree hatching boxes etc. were designed and fabricated.





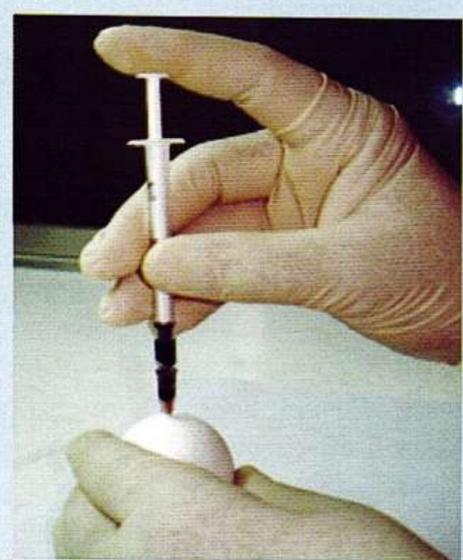
IN OVO FEEDING FOR IMPROVED MARKET WEIGHT

Administration of critical "external diet constituents" into the amnion or yolk sac of the late term embryo by a novel technology as "*in ovo* feeding" has been standardized. The *in ovo* feed nutrients are subsequently exposed to tissues of the gastrointestinal tract after the embryo orally consumes the amnion contents prior to air cell emergence (piping). *In ovo* feeding improves the nutritional status of the hatchling by accelerating enteric development for greater digestive and nutrient absorptive capacity and helps in better development of muscular, skeletal, circulatory, respiratory and immune system. Nutrient administration *in ovo* may provide poultry producers an alternative method not only to increase the chick weight at hatch but also improve the immunocompetence and market weight of the *in ovo* treated chicks.



FORMALDEHYDE INACTIVATED IN OVO VACCINE FOR CHICKENS

In an effort to provide early protection against deadly Newcastle disease (ND) formaldehyde inactivated *in ovo* vaccine for ND has been developed. The vaccine can be injected on 18th of embryonic age and does not adversely affect hatchability. Chicks hatching from vaccine injected eggs show evidence of protective immunity at hatch. The beauty of this technique is that it requires less vaccine dose, imparts less stress to the chicks, while being more effective than conventional vaccination.





Value Added Poultry Products

PROCESSED EGG PRODUCTS

ALBUMEN RINGS

Albumen rings are low fat egg snack food prepared by steam cooking blended egg albumen in ring molds, battering and breading the coagulated albumen and deep fat frying. The ready-to-eat rings contained 11.5% protein and merely 3.2% fat. This product can be safely stored by refrigeration ($4\pm 1^{\circ}\text{C}$) for 18 days in vacuum and 12 days in aerobic pack.



EGG RINGS

Egg rings are egg snack food prepared by steam cooking of blended liquid whole egg in ring molds, then battering and breading the coagulated rings and deep fat frying. The batter-breaded rings contained 12.3% protein, 11.2% fat and had a refrigerated ($4\pm 1^{\circ}\text{C}$) shelf-life of 12 days in aerobic packaging in polyethylene pouches.



EGG PANCAKES

Egg pancake is a convenience egg-rich product and can be popularized as a complete breakfast meal at homes as well as at growing fast food outlets. Ingredients used for preparing highly acceptable, light, fluffy and spongy pancakes include liquid whole egg, milk, wheat flour, sugar and baking powder. The pancakes had a refrigerated shelf-life of 12 days in vacuum packaging without any detectable deteriorative changes.



EGG PATTIES

Processing methodology and recipe for preparing egg patties has been standardized. The highly acceptable formulation included liquid whole egg, mashed potato, texturized soya flour, non-fat dry milk, spices, condiments and salt. Steam-cooked patties had a refrigerated shelf-life of 14 days in vacuum and 12 days in aerobic packaging, while at frozen temperature ($-18\pm 1^{\circ}\text{C}$) the product was stable for 90 days in vacuum and 80 days in aerobic packaging.





LOW-FAT EGG PATTY

A low-fat egg patty was developed, especially for health conscious consumers. The formulation ingredients include liquid egg albumen, mashed potato, textured soya flour, non-fat dry milk, salt, spices and condiments. The ready-to-eat fried patties contained 13.6% protein and merely 2.5% fat.

EGG-CRUST PIZZA

Process of preparing egg-crust pizza has been standardized. The pizza prepared with either foamed all-albumen crust, albumen flour-oil crust or albumen-skim milk solid-oil crust was rated best in sensory quality. The egg-crust pizza base has a refrigerated (5°C) shelf-life of 6 days in vacuum and 4 days in aerobic packaging. This product can be popularized as a meal or snack at fast food outlets.



EGG ROLL

Egg roll is a baked and breaded product with scrambled egg and chicken sausage filling. This product is suitable for either meals or in-between meal as snacks. The most acceptable recipe of egg filling consisted of 80% scrambled egg with 20% ground chicken sausage. This product can safely be stored by refrigeration (5°C) for 8 days in vacuum and 6 days in aerobic packaging.



BATTERED FRIED EGG

Battered fried egg is a hard cooked peeled egg, moulded with chicken sausage mixture around its plain surface, rolled in fine dry bread crumbs and deep-fat fried. It is a value-added convenience egg product in fast food establishments. Technology for preparing battered fried egg has been standardized. Shelf-life studies have shown that the product was microbiologically satisfactory and organoleptically acceptable for up to 12 days at refrigeration temperature.

PICKLED QUAIL EGGS

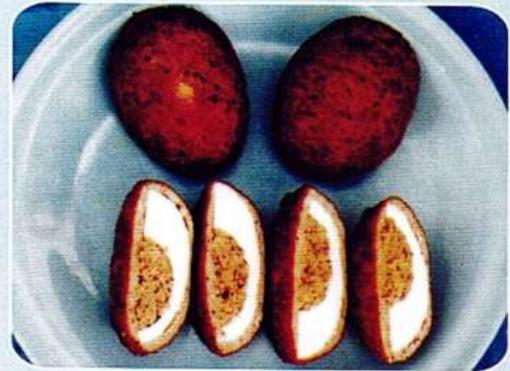
A simple, cost-effective and efficient technology for the development of ready-to-eat pickled quail eggs has been developed and perfected for commercial exploitation. The process, in brief, consists of hard cooking and peeling of eggs, preparation of vinegar based pickling solution or oil-based pickle gravy, seasoning and packaging in flexible/laminated thermoplastic pouches without the pickling solution. The product can be safely stored for about 4 months at room temperature and a year under refrigeration (5°C). The shelf-life of pickled eggs could be extended up to 8 months at room temperature under nitrogen gas packaging in laminated pouches.





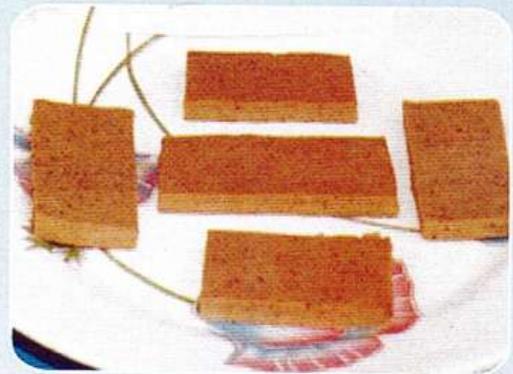
STUFFED AND COATED EGG

Processing techniques for preparing nutritious and delicious stuffed and coated egg have been standardized. The hard-cooked and peeled chicken egg was cut in half along the long axis, yolk removed, hollow of each half was filled with yolk and chicken meat mixes and wrapped in a thin layer of chicken meat emulsion and deep fried. The refrigerated ($4\pm 1^\circ\text{C}$) shelf-life of stuffed and coated egg was 18 days in vacuum and 16 days in aerobic pack.



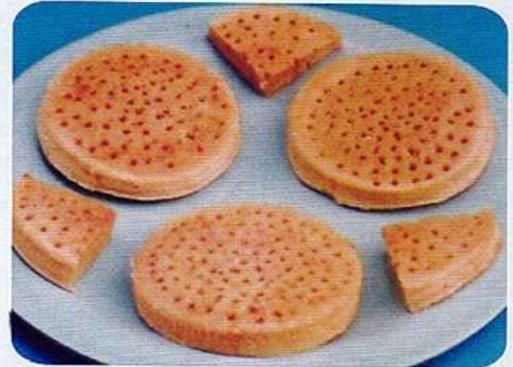
EGG STRIP

Egg strip is a nutritious and versatile snack food ideal for person of all ages. It is made from blended liquid whole egg combined with soya protein and spices. Egg strips are stable for 16 days in vacuum and 10 days in aerobic pack at refrigeration temperature ($4\pm 1^\circ\text{C}$) with a formulation cost of Rs. 40/- per kg.



EGG WAFFLES

Process of preparing egg waffles was standardized. Egg waffles prepared from liquid whole egg, wheat flour and granulated wheat had an ambient shelf-life of 4 days in vacuum and 3 days in aerobic pack as against 10 and 6 days in respective packs at refrigeration temperature.



PROCESSED POULTRY MEAT PRODUCTS

CHICKEN STEAKS

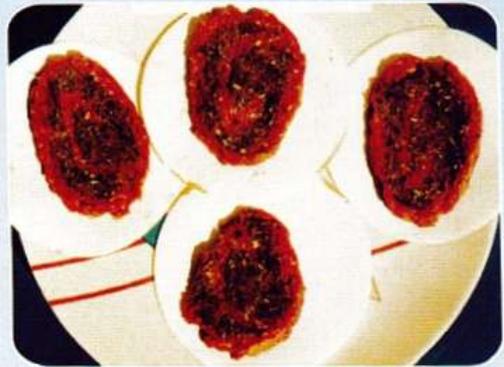
The technology for development of restructured chicken steaks utilizing spent hen meat has been standardized. A combination of textured soy protein and milk co-precipitate was found much more acceptable as extender and could be incorporated up to 30% level in chicken steaks' formulation. Packaging and shelf-life studies of the product indicated a refrigerated shelf-life of 9 days for vacuum packaged steaks as against 6 days for those packaged in low density polyethylene (LDPE) pouches. Under frozen storage ($-18\pm 1^\circ\text{C}$) the steaks of both packaging groups could safely be stored up to 60 days, however, vacuum packaged steaks were more acceptable throughout the storage.





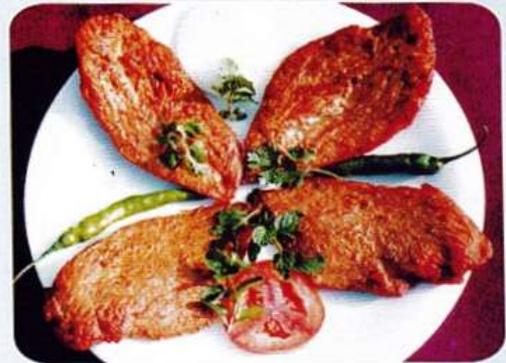
MIXED CHICKEN LOAF

Mixed chicken loaf made with dark meat from Kadakanath and broiler meat provided good appearance as well as flavour of indigenous fowl meat to the product. Experiments revealed that loaf prepared by replacement of meat with pulse as a binder and incorporation of 5% hydrogenated vegetable fat was rated good by the sensory evaluation panels. On evaluation of physico-chemical, microbial and organoleptic properties, it was found that the product could be safely stored up to 5 months at freezing temperature (10°C).



MARINATED CHICKEN BREAST FILLETS

Marination and processing techniques for the development of delicious, heat-and-serve chicken breast fillets have been standardized. The marinade contained cereal starch, common salt, citric acid, polyphosphate and spice mix. The process developed consisted of tumbling of excised broiler breast fillets (*Pectoralis superficialis*) with marinade mix slurry and oven roasting. Blade tenderization followed by still marination of fillets for 60 min. produced product with comparable quality as an alternative to tumbling. Vacuum or nitrogen gas packed fillets in aluminium-foil based (PFP) laminated pouches could be safely stored for 3 weeks and 3 months under refrigeration (4±1°C) and frozen (-18°C) storage as against 8 and 45 days long shelf-life of aerobically packed product, respectively.



EGG-MEAT PATTIES

Inclusion of meat in egg product formulations is not new to the egg products industry and such products have been found popular in many developed countries. On similar line, egg-meat patties have successfully been developed incorporating minced chicken meat in egg patty formulation. Other ingredients included textured soya flour, spice mix, onion-ginger paste and salt. This highly acceptable product was stable for up to 14 days under refrigeration (5±1°C) and up to 90 days under frozen (-18±1°C) conditions.

CHICKEN SAUSAGE

Chicken sausage production is a good way of utilizing culled/spent hens in more profitable manner. The recipe and methods of preparation have been standardized in the laboratory. Chicken sausage mainly contains 50-60% meat, 7-15% fat and 5-10% binders in addition to extenders, preservatives and seasonings. The finished product cooked by various methods has been rated as highly palatable by panelist on sensory evaluation trials.





The shelf-life of the product is about 7 days at refrigerated temperature (4°C) and 3 months under frozen (-18°C) storage. The product has got a great market potential.

CHICKEN PATTIES

Chicken patty can be prepared with meat from spent hens. The recipe has been standardized. It has been found from the studies that chicken fat can be used up to 12% in preparation of the product. The pre-cooked patties can be stored for 10 days under refrigeration (4°C) and 60 days in the frozen (-18°C) state.



INTERMEDIATE MOISTURE CHICKEN MEAT

An optimum infusion solution and processing technology for the preparation of intermediate moisture chicken meat (IMCM) for storage at room temperature has been standardized. Infusion solution recipe included humectants like common salt, glycerol and cane sugar, trisodium citrate, STPP and sodium benzoate. The process standardized for manufacturing IMCM consisted of a combination of humectants and hurdle technology viz. dipping of dressed chicken in 2% lactic acid dip for 2 min, dicing of meat into chunks, soak equilibration for 12 h in infusion solution and turmeric-garlic paste application prior to 4 h of oven drying (80±2°C). The finished product packaged in flexible-HDPE pouches has a shelf-life of 2 months at mean room temperature (24°C).

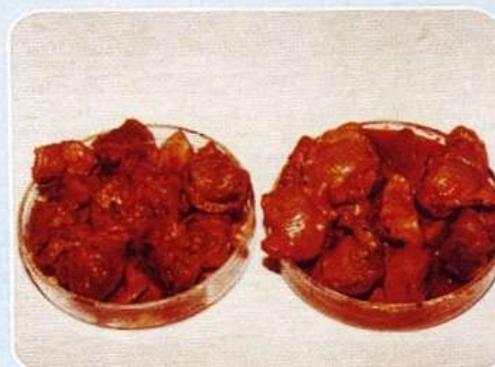


CHICKEN MEAT SPREAD

Chicken spread from pre-cooked, deboned and minced spent hen meat (85%) in combination with cereal starch, egg yolk, seasonings and permitted food additives was developed. The process, in brief, consisted of addition of 20% potable water to meat emulsion so as to improving spreadability prior to packaging and thermal processing in hot water bath to an internal temperature of 78±1°C for gelatinisation of starch and stabilization of the emulsified product. The product can be safely stored for 12 and 60 days under refrigerated (5±1°C) and frozen (-18°C) storage, respectively.

CHICKEN GIZZARD PICKLE

Chicken gizzard pickle is a comparatively cheap fast food with prolonged storage stability at room temperature. Small entrepreneurs may be attracted to produce and market the product by meagre financial investment. Gizzard pickle (oil based as well as vinegar based) contained about 22% crude protein and 9 to 10% total lipids with calculated caloric yield ranging from 262 (vinegar based) to 282 (oil based). These pickles can be





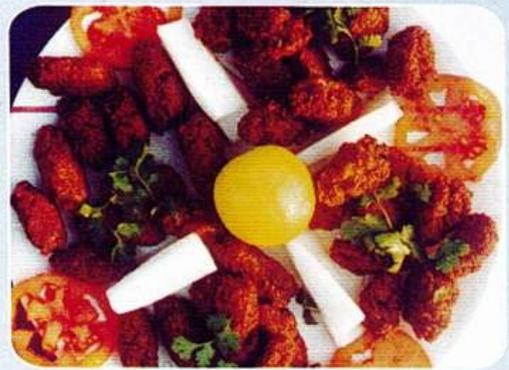
stored at ambient temperature (34°C) for 45 days during summer and rainy season and for 75 days in winter (26°C).

COOKED CHICKEN ROLL

Cooked chicken roll is a novel, ready-to-consume, fast food requiring mild warming before use. Processing is based on cut cost technology without compromising on nutritive value through use of processed/roasted gram flour. The product can be safely stored till 4 weeks under freezing temperature ($-18\pm 1^\circ\text{C}$) and for 2 weeks when kept under refrigeration temperature ($4\pm 1^\circ\text{C}$). Depending upon the mode and place of marketing, the profit may vary from 40 to 60% of the production cost.

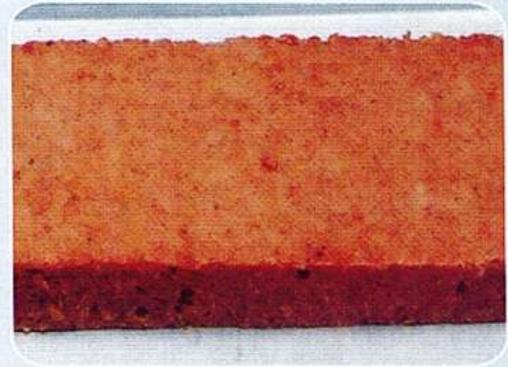
CHICKEN-SKIN MEAT CUTLET

Based on utilization of completely de-feathered chicken skin upto 30% (w/w) supplementary level with minced meat, the formulation methodology for processing chicken-skin meat cutlet has been standardized. The product can be consumed till 14 and 28 days of refrigerated ($4\pm 1^\circ\text{C}$) and frozen (-18°C) storage, respectively.



SPENT HEN MEAT BLOCK

In order to explore an avenue for the disposal of less preferred spent (culled) hens, a by-product of layer industry, processing technique for preparing comminuted spent hen meat block was standardized. The optimum formulation consisted of 60% minced spent hen meat, 15% skin, gizzard and heart in natural proportion in combination with binders/extendors, edible oil, seasonings and 0.5% polyphosphate. Mild acidulation (0.4% lactic acid) of the meat emulsion appeared beneficial in lowering its pH without imparting perceptible sourness in the product. This treatment resulted in extending the refrigerated ($5\pm 1^\circ\text{C}$) shelf-life of the product up to 15 days as against 10 days for that devoid of added organic acid.



CHICKEN CHUNKALONA

A process for preparing delicious chicken chunkalona from a combination of minced spent hen meat (60%), pre-marinated tender broiler meat chunks (25%) along with binders, extendors and seasonings was optimized. The product packaged in retortable 3-ply laminated (polyester/foil/pp) pouches and then subjected to retort processing (1 kg/cm^2 ; 30 min.) had microbiologically safe and organoleptically acceptable shelf-life of 2 weeks under ambient (25°C) storage.





COOKED CHICKEN STOCK

It is an instant chicken meat product reconstitutable to curried chicken dish. It can be packed in ordinary, laminated aluminium foil pouches and can be stored upto 14 days refrigerated (5°C) or 28 days under frozen storage (-18°C) conditions.



CHICKEN GIZZARD SNACKS

In order to develop low cost convenient chicken meat products, the cost-effective method of preparing chicken gizzard snacks has been standardized. Such snacks made with 8% water medium garlic extract could be kept for 18 and 35 days under refrigeration ($4\pm 1^{\circ}\text{C}$) and freezing (-18°C) temperatures, respectively.

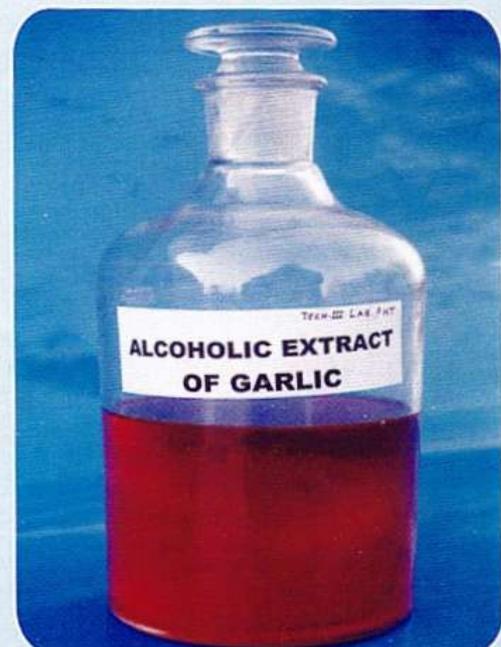
ELECTRICAL STUNNING OF CHICKEN

Pre-slaughter electrical stunning of poultry to render them unconscious prior to slaughter is an important consideration for addressing poultry welfare concern. Hence, studies carried out on the optimization of effective stunning conditions for chickens in a saline (1%) water bath stunner of overhead conveyor line revealed that effective voltages for proper stunning of chicken broilers and spent hens were 70 V and 80 V, respectively for 14 sec each without any adverse effect on the carcass and meat quality.



SHELF-LIFE EXTENSION OF CHICKEN MEAT USING NATURAL PRESERVATIVES

Shelf-life of minced chicken meat treated with 4% garlic extract or 2% cinnamon powder or 0.25% clove oil could be extended from 6 to 12 h at ambient ($27-34^{\circ}\text{C}$) temperature, while 4% cinnamon powder treatment almost doubled its shelf-life up to 8 days under refrigeration ($4\pm 1^{\circ}\text{C}$) storage. Similarly, dressed chicken carcass dipped in 4% cinnamon solution was found to remain fit for consumption up to 12 h at ambient ($18-20^{\circ}\text{C}$) and up to 10 days at refrigeration ($4\pm 1^{\circ}\text{C}$) temperatures.





POULTRY BY-PRODUCTS BASED PET FOODS

A simple, cost-effective and efficient process for the conversion of poultry offals into nutritious and highly palatable food for pet dogs has been developed. The process, in brief, consisted of autoclaving of freshly collected and cleaned inedible chicken offals (excluding feathers) plus giblets (heart, gizzard and liver) at 1 kg/cm² pressure for 30 min. and 10 min. for blood, mincing the autoclaved material and blood coagulum in 5 mm sheath mincer, oven drying (70°C, 16 h), grinding, sieving, addition of 0.02% BHA as antioxidant, packaging in LDPE (300 G) pouches to prepare poultry



by-product meal (PBPM). This PBPM at 15% level could be mixed with leaker egg liquid (20%), bakery waste (20%), maize flour (24%), wheat flour (10%), defatted soy flour (5%), soybean oil (5%), common salt (1%) and permitted food additives (0.02% BHA), 0.5% STP, 0.2% citric acid, 0.05% vitamin and mineral mixture to prepare dough of thick consistency. Forced oven drying (100±1°C, 8 h) of about 1.5 cm thick dough spread in stainless steel trays yielded finished rectangular shaped pet biscuits rich in nutrients. The finished product contained about 95% dry matter, 23.7% crude protein, 18% fat, 52% nitrogen-free extract, 4.8% ash, 0.77% calcium, 0.70% phosphorus, 0.82% lysine, 0.51% methionine and 4.2 kcal/g ME. Feeding 100 g of this pet food to adult pet dogs would contribute to 50 to 60% of daily maintenance requirements for ME, CP, Ca, P available lysine and methionine of pet dogs. The cost of this pet food worked out to be Rs 15/kg. Technology for preparing semi-moist intermediate moisture pet food, using humectants, has also been developed for young pups.

TENDERIZATION OF SPENT HEN MEAT

In order to improve the marketability of spent hens/culled breeding stocks, whose demand is on the decline due to toughness of their meat, carcass fatness and increased availability of broilers, a simple technique for the tenderization of such tough meat has been evolved. The process standardized consists of soaking of eviscerated spent hen/culled breeding stock carcass for 3 h in 0.05% papain or 0.075% trypsin in combination with 1.0% sodium chloride and 0.05% sodium tripolyphosphate. This tenderization method is superior to the cumbersome and commercially impracticable intravenous or intraperitoneal injection of enzymatic solution prior to slaughter of birds.

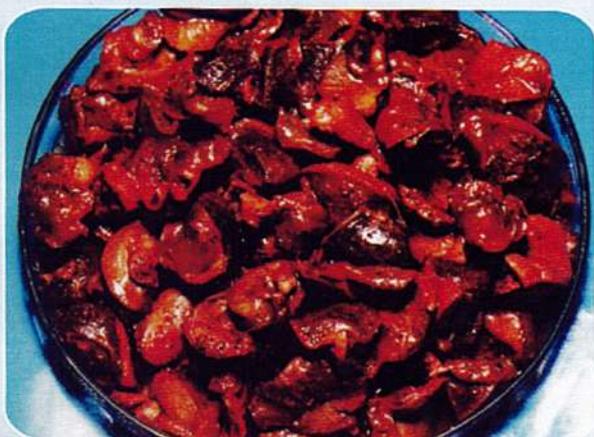
BIO- AND PHYTO-CONTAMINANTS ASSAY TO ADDRESS FOOD SAFETY CONCERN

Keeping in view the emerging food safety issues in the prevailing WTO regime, PCR-based molecular methods for quick and sensitive detection of some pathogens (*Salmonella typhimurium*, toxigenic *E. coli*, *compylobacter*) were standardized and their decontamination with acidified sodium chloride (3.5 ppm) optimized. Besides, microbial profile of eggs collected from the farms and marketing channels of Northern India was ascertained. In addition, residues of some potent pesticides (BHC, DDT, aldrin, dieldrin, melathion, chloropyriphos, monocrotophos, dichlorovous), aflatoxin and heavy metals (lead, arsenic, copper, cobalt and molybdenum) in poultry feed, egg and spent hen tissues were determined and effect of cooking methods on reduction in residue of pesticides was ascertained. All these residues analyzed were found to be below their respective maximum residual limits (MRL).



PROCESSES PATENTED

- Method of preparation of Mustard Oil Based Chicken Gizzard Pickle Indian Patent No. 180509
- Method of preparation of Vinegar Based Chicken Gizzard Pickle Indian Patent No. 183900
- Method of preparation of Mixed Chicken Loaf Indian Patent No. 184430
- Method of preparation of Cooked Chicken Stock Indian Patent No. 185748
- Method of preparation of Cooked Chicken Roll Indian Patent No. 188420
- Nucleic Acid Amplification-Allele Differentiating Restriction Pattern (NA-ADRP)-A Noble Method for Determining the MHC Genotype of Chicken Filed
- A Process for Preparation of Copper Cadmium Alloy Filings for the Determination of Nitrite and Nitrate Filed





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**CONSUMPTION OF EGG AND POULTRY MEAT IS SAFE AND
BENEFICIAL FOR HUMAN HEALTH**

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