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Ebola Virus Disease - A Threat for Human

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Ebola Virus Disease- A Threat for Human

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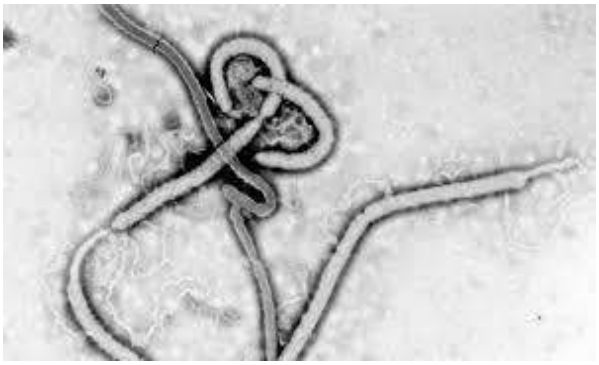
Ebola virus disease (EVD), formerly known as Ebola haemorrhagic fever, is a severe, often fatal illness in humans. EVD outbreaks have a case fatality rate of up to 90%. EVD outbreaks occur primarily in remote villages in Central and West Africa, near tropical rainforests. The virus is transmitted to people from wild animals and spreads in the human population through human-to-human transmission. Fruit bats of the Pteropodidae family are considered to be the natural host of the Ebola virus. Severely ill patients require intensive supportive care.



No licensed specific treatment or vaccine is available for use in people or animals. Ebola first appeared in 1976 in two simultaneous outbreaks, in Nzara, Sudan and in Yambuku, Democratic Republic of Congo. The latter was in a village situated near the Ebola River, from which the disease takes its name. Genus Ebola virus is 1 of 3 members of the Filo viridae family (filovirus), along with genus Marburg virus and genus Cueva virus. Genus Ebola virus comprises five distinct species: 1. Bundibugyo ebolavirus (BDBV) 2. Zaire ebolavirus (EBOV) 3. Reston ebolavirus (RESTV) 4. Sudan ebolavirus (SUDV) 5. Tai Forest ebolavirus

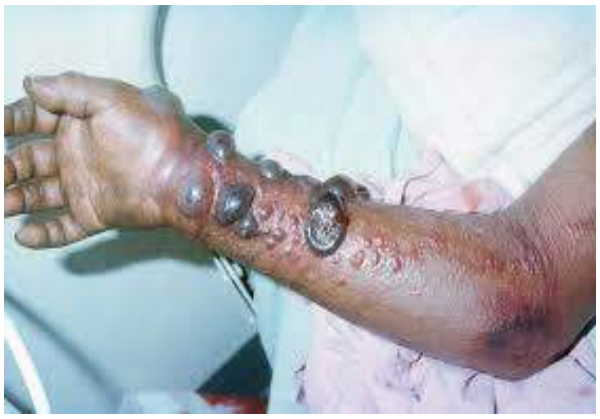
TRANSMISSION

Ebola is introduced into the human population through close contact with the blood, secretions, organs or other bodily fluids of infected animals. In Africa, infection has been documented through the handling of infected chimpanzees, gorillas, fruit bats, monkeys, forest antelope and porcupines found ill or dead or in the rain forest. Ebola then spreads in the community through human-to-human transmission, with infection resulting from direct contact (through broken skin or mucous membranes) with the blood, secretions, organs or other bodily fluids of infected

people, and indirect contact with environments contaminated with such fluids. Men who have recovered from the disease can still transmit the virus through their semen for up to 7 weeks after recovery from illness. Health-care workers have frequently been infected while treating patients with suspected or confirmed EVD. Among workers in contact with monkeys or pigs infected with Reston ebola virus, several infections have been documented in people who were clinically asymptomatic. Thus, RESTV appears less capable of causing disease in humans than other Ebola species. Health effects of the virus to all population groups, such as immuno-compromised persons, persons with underlying medical conditions, pregnant women and children.

SIGNS AND SYMPTOMS

EVD is a severe acute viral illness often characterized by the sudden onset of fever, loss of appetite, intense weakness, headache, sore throat, joint, muscle and abdominal pain. This is followed by vomiting, diarrhoea, rash, impaired kidney and liver function. Less common symptoms include the sore throat, chest pain, hiccups, shortness of breath and trouble swallowing. In some cases, both internal and external bleeding also occurs.



Laboratory findings include low white blood cell and platelet counts and elevated liver enzymes. Ebola virus was isolated from semen 61 days after onset of illness in a man who was infected in a laboratory. The incubation period is 2 to 21 days.

DIAGNOSIS

Ebola virus infections can be diagnosed in a laboratory through several types of tests: antibody-capture enzyme-linked immune sorbent assay (ELISA), antigen detection tests, serum neutralization test, reverse transcriptase polymerase chain reaction (RT-PCR) assay, electron microscopy and virus isolation by cell culture.

VACCINE AND TREATMENT

No licensed vaccine for EVD is available. Several vaccines are being tested, but none are available for clinical use. Severely ill patients require intensive supportive care. Patients are frequently dehydrated and require oral rehydration with solutions

containing electrolytes or intravenous fluids. No specific treatment is available.

PREVENTION AND CONTROL

Routine cleaning and disinfection of pig or monkey farms (with sodium hypochlorite or other detergents) should be effective in inactivating the virus. If an outbreak is suspected, the premises should be quarantined immediately. Culling of infected animals, with close supervision of burial or incineration of carcasses, may be necessary to reduce the risk of animal-to-human transmission. Restricting or banning the movement of animals from infected farms to other areas can reduce the spread of the disease. Reducing the risk of Ebola infection in people in the absence of effective treatment and a human vaccine, raising awareness of the risk factors for Ebola infection and the protective measures individuals can take is the only way to reduce human infection and death. Reducing the risk of wildlife to human transmission from contact with infected fruit bats or monkeys/apes and the consumption of their raw meat prevent a spread of the virus. Animals should be handled with gloves and other appropriate protective clothing. Animal products (blood and meat) should be thoroughly cooked before consumption. Reducing the risk of human-to-human transmission in the community arising from direct or close contact with infected patients, particularly with their bodily fluids will prevent spread of transmission among human. Close physical contact with Ebola patients should be avoided. Pig farms in Africa can play a role in the amplification of infection because of the presence of fruit bats on these farms. Appropriate biosecurity measures should be in place to limit transmission. For RESTV, educational public health messages should focus on reducing the risk of pig-to-human transmission as a result of unsafe animal husbandry and slaughtering practices, and unsafe consumption of fresh blood, raw milk or animal tissue. Gloves and other appropriate protective clothing should be worn when handling sick animals or their tissues and when slaughtering animals. In regions where RESTV has been reported in pigs, all animal products (blood, meat and milk) should be thoroughly cooked before eating. Human-to-human transmission of the Ebola virus is primarily associated with direct or indirect contact with blood and body fluids. Transmission to health-care workers has been reported when appropriate infection control measures have not been observed.

Fisheries Sector in Kashmir

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Fisheries play an important role in the economy of India in generating employment, supplying food supply, earning foreign exchange. The production of fish in the country has increased by average growth of about 80%. The state (J&K) has been gifted by many water resources. Fish production nuds high priority by way of implementation of different schemes, technologies and all will go along way in achieving sustainable fish production in the country. Indian fisheries are an important component of the global fisheries with India being 6th largest producer of fish amount in to 5.49mmt. In case of aquaculture it produces 2.44mm t from the inland fisheries sector being on the 2nd position in the world. India is gifted by all types of fisheries warm watered as well as cold watered fisheries. About cold water fisheries most of the production comes from the Himalayan zones like that of H.P. & Kashmir. Kashmir Valley, situated between 330-1'-350 Northern latitude and 730-48'-300 east longitude at an elevation of more than 1500 meters above sea level, is a part of Himalaya Mountain system. It encloses the area of 5208 Sq km and is enclosed by Himalaya on all sides except an opening towards its west, by the overflow of river Jehlum. No doubt, Kashmir is unrivalled for its beauty. The snow covered hills of Himalayas protect it from the heat of the planes and blast of cooler regions of further north. The state has abundant resources of water in the form of wetlands, ponds, pools, streams, rivers, springs, reservoirs and a high priority needs to be given for the culture of common carp, trout's Mahaseer, schizothorax spp. Presently annual inland fish production (t) is about 16,520 which is little but low so steps should be taken for the increase in production.

Estimates regarding actual yield per hectare of Kashmir fisheries have been varying. There has been observed declining trend during past few years due to certain problem. Some of the problems have been noticed under:

Various problems responsible for low production can be broadly classified as Biological, Technological, Economical and Administrative & Legislative. AS the first two problems have received adequate attention in the past where as Administrative and Legislative problems are briefly explained as under:-

Economic Problem

Economic problems responsible for the low fish yield from different water bodies of Kashmir can be identified as:

- Low priority cold water fisheries been assigned a very low priority in the planning process. A huge amount after every five year plan is given to be for every state but unfortunately our state is given low funds or low priority which results in the low production.
- Multiplicity of ownership:- Fishing ownership in different water bodies of Kashmir is often controlled by different state departments viz, Fisheries, Irrigation, Revenue, Forest and even Tourism. This multiplicity becomes further complicated when more than one cooperative society harvest a single water body.
- Multiplicity of Rental System: This is another problem which also leads miss management to the water bodies and results in the low production. (Administrative factors).
- Conflicts: The management of water bodies inherits a large number of conflicts with irrigation, flood control, electricity generation, drinking water supply, industrial pollution, sport fisheries etc. These all departments lead direct effect on fish production.
- Seed shortage: Seed shortage is a chronic problem in the departments of water bodies. It may be noted that it is more a biological then an administrative problem.
- Underutilization: More than 50% water bodes of Kashmir are not utilized which leads in low production.
- Selection of species: Selection of candidate species for different water bodies are not done properly which also leads to low production.

- Lack of man power development: Lack of man power is the main cause of the low production. If we would have scientific man power with full awareness of science we would have increased our production up to high level.
- Unawareness about conservation: People of Kashmir even up to this level are unaware about conservation of fisheries resources which in side effects the production.
- (Technological problems): Here we don't have proper technical methods or technical instruments which can help us in proper consumption of fisheries resources. The improper crafts and gears leads to low production.
- (Biological problems): Main problem which we are facing is the water pollution which directly effect to the production of fisheries. This pollution leads to the total decline for the resource of the Kashmir.

STRATEGIES FOR IMPROVEMENT OF PRODUCTION

In order to make our fisheries more profitable some immediate steps have to be taken. Even though it is not practically possible to have uniform measures for all the water bodies. Some action guidelines could be useful for a majority of them.

- It would be ideal if the people of surrounding areas are involved in this field. The locally available manpower can be utilized for hatchery management, seed production, seed stocking, harvesting, guiding the fish stock, net mending, boat and gear operation it would absorb a good number unemployed rural youth.
- Each single water bodies should be considered as on unit with all the infrastructural requirements viz. Fish seed production and raising complex approach roads fishing boats gears transportation etc.
- There should be an all Kashmir fisheries development authority under a joint commissioner of fisheries at Ministry of Agriculture to monitor and implement programmes.
- There should be three to four well established marketing centers in each zone of Kashmir for improving fish marketing systems.
- Fishery estates may be set up.

- Indigenous food production should be promoted.
- Administration of antibiotics for control of diseases should be discouraged. Infrastructure disease control and monitoring should be set up.
- Guidelines formulated by the Pollution Control Board should be followed.
- Land lease policies may be implemented speedily by the state government.
- Quality standards relating to the various stages of culture may be evolved and introduced.
- The state Agricultural Universities, College of Fisheries which have necessary technical man power resources and facilities should organize the distance education programs for the fish farming community.
- KVK model under ICAR should be promoted for the awareness of people.
- Strong linkage between the national institutes should be done.
- Economic problems which J&K State is facing should be discussed for benefit of this discipline.
- Low priority should be also discussed.
- Multiplicity of fishing ownership should be banned.
- Conflicts between different departments which are concerned with water bodies should be solved.
- Seed shortage problem should be solved by proper mange mental practice.
- Underutilization should be observed and utilization steps should be taken.
- Proper selection of species should be taken for proper water bodies.
- Lack of man power can be improved by providing training on different programmes of fish culture.
- Improvement in on fishing gears and crafts is necessary.
- Efforts for completion of basic infrastructure both in Hatchery and Farm fisheries.

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Improving Milk Production of Indian Livestock by Assisted Reproductive Technologies

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India is the largest milk producer in the world with around 127.9 Million Tones production. According to reports, seeing the rate of population growth, the country is estimated to require 150 million tonnes of milk by the end of 12th Five Year Plan period (Economic survey of India, 2012). To meet the increasing demand of milk and milk products of the country, it is important to improve productive and reproductive efficiency of livestock by various reproductive technologies. Several reproductive technologies are available so far such as Artificial Insemination (AI), Multiple Ovulation Embryo Transfer technique (MOET), In vitro fertilization (IVF), Semen sexing, Cloning and Transgenesis. These techniques increases reproductive efficiency, transportation and multiplication of germplasm becomes easier. With these technologies we can conserve germplasm for future use. The technologies like AI, MOET, IVF and Semen sexing increases distribution of superior germplasm and increases selection intensity. The techniques like cloning and transgenesis transform DNA and improve genetic determination of animals. India has the world's largest Artificial Insemination Infrastructure producing 37 million frozen semen straws annually. Main advantage of using AI is the dissemination of superior germplasms, progeny testing under different environmental conditions so as to increase the rate and efficiency of selection. In commercial dairy production, over 80% of cattle are bred artificially. India has 54 functional frozen semen stations and 84,000 AI centres, out of which 48,000 is under government sector. In October, 2000 Government of India had initiated National Project on Cattle and Buffalo Breeding (NPCBB) policy for improved artificial insemination service at the farmer's doorstep, supply of genetic inputs as well as liquid nitrogen to a specialized autonomous and professional State Implementing Agency. Through AI, the overall conception rate of Indian cows has increased from 20% to 35% and the coverage of Indian breedable bovine population has increased to 25 %. The

main proportion of success of AI in Indian bovines is due to improvement in genetic potential through the use of outstanding sire.

In vitro fertilization technique in which the oocytes (unfertilized eggs) are extracted from a donor cow by ultra sounded method of aspiration and fertilized in vitro using capacitated sperm. In vitro fertilization creates the immediate benefit of multiplication of superior germplasm and serves as a tool for conservation of precious genetic resources facing extinction. In IVF superovulation of cows is not necessary, nor is it necessary to synchronize them. Cows can be aspirated every 20 days instead of every 60 as in In Vivo embryo collection. By IVF, animals can be harvested at a very young age thereby reduces the generation interval for the animals with a specific desirable trait. National dairy Research Institute, Karnal has produced IVF buffalo calf " Pratham", goat kid and Sahiwal calf "Holi". Multiple Ovulation Embryo Transfer (MOET) is the procedure used to optimize reproductive capacity in females through the use of superovulation, fertilization, embryo recovery and short term in vitro culture of embryos, embryo freezing and transfer. MOET can increase the rate of genetic improvement upto 20 per cent compared to other breeding tools, used for obtaining more than the normal number of offspring from highly prized (Superior) cows or breeds, can be introduced to organized herds for faster production and evaluation of bulls. There

Cloning a male buffalo calf named 'Shresth' (NDRI)

are two types of MOET 1) Juvenile MOET and 2) Adult MOET. In Juvenile MOET, selection of cow and bull done at 12-18th month based on ancestors performances. In Adult MOET, bulls are selected on the basis of ancestor performance plus full & half female sibs while cows are selected on the basis of ancestor performance plus their performance. Now a days, government, NGOs and private agencies are using MOET technology for faster multiplication of superior germplasm.

Semen sexing is the process of predetermination of sex of offspring in livestock species. It has various commercial and research applications, alter male and female ratios in farm animals and increase the meat and milk

production. Semen sexing is mainly done by Flow cytometry. Major government Institutions and organized dairy farms are using this technology for increasing the production of dairy animals. Cloning is the process of creating an identical copy of an original organism. Clone can be called as group of two or more individuals with identical genetic makeup, derived by asexual reproduction, from single common parent or ancestor. Somatic cell or embryonic stem of animals can be used for cloning. The animals with desired traits can be produced. Multiplication of proven bulls for increasing production, offset losses of among endangered species populations and production of animal models are the various advantages of cloning. National Dairy Research Institute, Karnal has produced cloned buffalo calf "Samrupa", "Garima I", "Garima II" and "Shresth" by cloning. SKUAST, Jammu had produced cloned Pashmina goat "Noorie" from adult ear somatic cell. Transgenesis is a procedure in which a gene or part of a gene from one individual is incorporated in the genome of another with intervention of man. Transgenic animals are used for drug and industrial production, model for the study of gene function and mechanism of action, disease models and organ transplantation. Over the past twenty five years, the above reproductive technologies have become a crucial part of cattle breeding in most of the developed countries. However, in India use of these techniques are limited because of high cost and lack of infrastructure. Therefore, in the present scenario, we should concentrate on following objectives to increase the milk production of the country:

1. Selection and multiplication of genetically superior animals at the institutional farms and progressive farmer herds
2. Establishment of quality germplasm production centers in the form of breeding bulls, semen, embryos and their dissemination
3. Conservation of germplasms particularly endangered breeds through AI, IVF, Semen sexing, Cloning.
3. Breeding facilities through establishing AI and Animal Health centers at the farmer's doorsteps, well equipped with trained village level inseminators and para veterinary staff
4. Reducing the number of unproductive animals
5. Multiply the superior germplasm from reproductive failure animals also
6. Production of designer animals for drugs, food, disease models etc.

Medication Beyond Their Expiration Date

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The expiry date is that point in time when a pharmaceutical product is no longer acceptable specifications for potency and stability. Drug expiration dates exist on medication labels, including prescription, over-the counter and dietary supplements. The expiration date on the label indicates that the medication is effective until the last date of the month listed. For example, if the expiration date is listed as July 2014, the medication would be expected to remain effective until July 31, 2014. The **shelf life** of a drug is the time within acceptable specifications for potency and other important parameters. During the period of shelf life, the potency of the drug should be maintained above 90 per cent. In general, shelf life of drugs will be 1 to 5 years. In India, shelf life of drug and its storage methods are regulated under Drug and Cosmetic Schedule B act. **Stability** of a pharmaceutical product is defined as the "extent to which a product retains, within specified limits and throughout its period of storage its use, the same properties and characteristics that it possessed at the time of manufacture". The expiration date of a drug is estimated using stability testing as determined by the Food and Drug Administration (FDA). A product must meet standards for five types of stability;

1. Chemical
2. Physical
3. Microbiological
4. Therapeutic
5. Toxicological

1. Chemical Stability: It means that the chemical structure of the active ingredient remains intact and that the potency is acceptable. Generally, a drug product must retain 90% of its potency to be considered acceptable.

2. Physical Stability: It refers to the way the product appears (eg. discolouration), taste and smells.

3. Microbiological Stability: It means the product remains free of bacteriological and fungal growth.

4. Therapeutic Stability: It refers that the product is able to exert the same actions in the body, leading to its effects against the disease it is intended to treat.

5. Toxicological Stability: It indicates that an increase in toxicity does not occur as time passes.

Medications beyond their expiration date

- The most common consequences of an expired medication are **loss of potency** and thus effectiveness the product does not guaranteed. Even after expiry date, most oral medications do not pose major safety concerns. Adverse effects directly related to expired medications are rare. But, some reports were available for usage of expired medicines with toxic effects. One such example is the antibiotic tetracycline, which decomposes to toxic products. Utilization of expired tetracycline caused serious damage to kidneys which is known as 'Fanconi Syndrome'.
- Solid dosage forms, such as tablets and capsules, appear to be most stable past their expiration date.
- Drug exists in solution forms or a reconstituted suspension, and that require refrigeration may not have the required potency if used when outdated.
- Antibiotic after its expiration date may lose its potency. Hence, usage of antibiotic after its expiration date may lead the major problem of **antibiotic resistance**.
- Epinephrine injection should not be used after its expired date as lose its potency.
- Ophthalmic (eye) drops should not be used after its expiration date. Because outdated preservatives in the eye drops may allow bacterial growth in the eye drops.
- Insulin may be susceptible to degradation after its expiration date.
- Oral nitroglycerin may lose its potency quickly once the medication bottle is opened.
- Vaccine, biological and blood products could also be subject to quick degradation once the expiration date is reached.
- The variation in the heat and humid climates affect the potency of the oestradiol patch.
- Drugs exist in solution, especially injectable drugs, should be discarded if the product forms a precipitant or look cloudy or discoloured.

Storage conditions of medicines

Proper storage of medications under recommended conditions remain stable with their potency. Special precaution may be necessary for protecting the medication from temperature variation

and light. Light, especially ultraviolet light, may cause photochemical reactions to occur, leading to drug degradation. The medications have to be stored as per the manufacture instructions. From this review, it can be concluded that, medicines has to be stored as recommended and discard them after the expiry date.

Definitions for temperature and humidity:

SR.No.	Condition	Temperature Requirements
1.	Freezer	-25^0 to -10^0 C (-13^0 to -14^0 F)
2.	Cold (Refrigeration)	2^0 to 8^0 C (36^0 to 46^0 F)
3.	Cool	8^0 to 15^0 C (46^0 to 59^0 F)
4.	Room temperature	Temperature in work area
5.	Warm	30^0 to 40^0 C (86^0 to 104^0 F)
6.	Dry place	Humidity must be less than 40% at controlled room temperature

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Immunization Strategies against HS, FMD, Brucellosis and Theileriosis in dairy animals

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Immunization strategy is one of the most important part of comprehensive disease control programme. Quality veterinary vaccines used strategically can improve the health and welfare of companion animals, increase production of livestock in a cost-effective manner and present animal to human transmission from both domestic animal and wildlife. It has impact on human health through increasing safe food supplies. Vaccination has been proven to be a very effective way of controlling and eliminating the most important, infectious diseases like HS, FMD, Brucellosis and Theileriosis which have high economic significance in livestock industry. Large scale immunization of all the susceptible livestock proper time using a potent vaccine is essential in achieving effective disease control. Application of biotechnological tools like recombinant – DNA, hybridoma technology etc for novel vaccine needs to be adopted.

Hemorrhagic Septicaemia (HS):

HS is an acute septicaemic disease occurring most often in cattle, buffalo, sheep, goat, camel and pigs following some form of stress caused by bacteria *Pasturella multocida*. It causes heavy death losses. Particularly when the animal is exposed to wet, chilly weather or exhausted by heavy work. Animals of all ages are susceptible but the most susceptible age group is 6 months to 2 years of age. Outbreak of the disease most often associated with wet humid weather during the rainy season. The organism may be present in respiratory tract as commensal and may not be able to produce the disease alone, but the predisposing factors like humid atmosphere, transportation, over excretion, starvation, close confinement, worm infestation especially in monsoon season make favourable environment for the multiplication of organisms to assume virulent role and set up the disease process. The maximum incidences are observed in

monsoon. Hence vaccination programme for HS must be carried out a month before the monsoon starts.

Foot & Mouth Disease (FMD):

It is an old disease that have frightened the farming community since the 1500s.It is caused by a virus that exist in a 7 different forms called serotypes. Four serotypes O,A,C and Asia I are reported in India with no report of serotype C since 1995.All cloven hoofed animals including cattle, buffalo, sheep ,goat ,pig and other ruminants are prone to the infection. The wide host range and rapid spread of the disease represent the cause for its international concerns because of its rapid spread sometime FMD is elaborated as "Fast Moving Disease". Different animal species react to a FMD in different ways. Sheep and goats are considered maintenance hosts in that they have mild clinical signs. Pigs are amplifying hosts in that they concentrate the virus in their respiratory secretions are much more infective via aerosol. Cattle are indicator hosts because they most often are the first spp. to show clinical signs with more several lesions. Animals with FMD usually recover uneventfully, but the highly infectious nature of the virus has profound economic consequences. Part of the economic impact stems from production losses in intensive production systems, such as dairy industry, where cattle may experience chronic mastitis, poor growth and permanent hoof damage. Even one case of FMD in nation is enough for other countries to close their borders to animals or animal products from the infected nation. The cost of an outbreak can run into billions of dollars for govt., besides the cost to farmers and rural business that suffers economic losses. The economic losses are mainly in form of loss in milk production, reduction in working ability of draught animals and reduction in body weight, leads to reduce in milk yield. In addition, the hide is not accepted by the countries which are free from the disease.

In the endemic countries, eradication does not seem possible within the foreseeable future and countries free of the disease may require regional vaccination during outbreaks. Serviceable immunity after a single vaccination can be relied on for only 6-8 months. Vaccines produced from 'natural' virus give longer immunity than those produced from 'culture' virus. A general vaccination programme for an area must be planned for that area. Calves from unvaccinated dams should be vaccinated at 4 months and revaccinated at 8 months of

age, but calves from vaccinated cows should be vaccinated twice, the first at 6 months and the second at 10 months of age. The important considerations in calves are to avoid vaccination while the calf is still carrying maternal antibodies derived from colostrum and to avoid infection.

Brucellosis:

It is an acute and chronic contagious disease of domestic animals caused by *Brucella* spp.and causes plecentitis and abortion. It is widely prevalent throughout the country among bovine population. It causes huge economic losses to livestock industries through abortion, delayed conception, temporary or permanent infertility. The disease in cattle, water and buffalo, is caused almost exclusively by *Brucella abortus* and occasionally by *B.suis* or *B.melitensis*. Infection spread rapidly and causes abortion in unvaccinated cattle herd. In a herd in which disease is endemic, an infected cow typically aborts only once after exposure; subsequent gestations and lactation appears normal. Transmission occurs by ingestion of contaminated feed and water with aborted fetuses, fetal membranes and uterine discharge. Venereal transmission by infected bulls to susceptible cows appears to be rare. Transmission may occur by AI when *Brucell*a contaminated semen is deposited in the uterus. *Brucellae* may enter the body through mucus membrane, conjunctivae, wounds or intact skin. Abortion in last trimester of pregnancy is the most obvious manifestation. Infection may also cause still born or weak calves, retained placentas, and reduced milk yield. Organisms are localized in the supra mammary, iliac and retro pharyngeal LN. Animal may develop hygroma. Usually general health is not impaired in uncomplicated abortions. In bulls, seminal vesicles, ampullae, testicles and epididymides may be infected leading to epididymitis and orchitis; there for organisms are present in the semen. A number of vaccines are in use but none is fully effective. In some countries vaccination is not permitted and eradication by test and slaughter is the only method of control. *B. abortus* strain 19 gives a high -level, durable immunity but the vaccine has several disadvantages. Vaccinated animals become seropositive, which hinders subsequent use of serological tests for eradication. Strain 19 itself can cause epididymitis and vaccinated rams may excrete strain 19 in their semen. Severe outbreaks of osteomyelitis and epiphysitis have been recorded in rams following vaccination. Vaccination is

carried out once in life of female calf of 4-8 months of age.

Theilerioses:

Theileriosis is a major tick borne haemoprotozoan disease of cattle, sheep, goat and wild and captive ungulates. Crossbreds and exotic cattle are highly susceptible to the disease. Theileriosis in Indian bovines is mainly caused by *Theileria annulata* and commonly known as bovine tropical theileriosis. Highest incidence of theileriosis is observed in calves in winter (Oct-Jan) followed by monsoon (June-Sept) and least in summer season (Feb-May). The prevalence of theileriosis varies from region to region, host to host and also depends on management and environmental factors. The common clinical signs in affected crossbred animals are rise in body temperature, enlargement of superficial lymph node, lethargy, tachycardia, polypnoea , reduced appetite, pale to icteric mucous membrane with protrusion of eye ball in a few cases and bulging of supra orbital fossa. Effective drugs used worldwide for the treatment of tropical theileriosis include mainly buparvaquone, oxytetracycline, diminazine aceturate and halofuginone. Among many drugs buparvaquone, second-generation hydroxynaphthoquinone is very effective and highly specific for the treatment of clinical cases of bovine tropical theileriosis. Buparvaquone is 93-100% effective in treatment. Control of theileriosis can be done by three ways, viz., chemoprophylaxis, immunoprophylaxis and tick control. In chemoprophylaxis buparvaquone is currently the drug of choice given at the dose rate of 2.5 mg/kg, intramuscularly at the age of 30 days. For immunoprophylaxis, Rakshavac-T vaccine is used for susceptible cattle under field condition. Control of ticks can be done by three methods, viz., physical methods, use of chemical agents and by use of bio-pesticide. It causes great economic loss. Indigenous cattle live with the disease and do not require any intensive tick control or treatment. For valuable exotic stock or their crossbreeds, vaccination and strategic tick control are recommended. It has been suggested that the most economical way to control theileriosis in India is to vaccinate calves and to reserve buparvaquone for treating clinical cases.

Sr. No	Name of disease	Trade name	Manufacturer	Strain/Subtype/Adjuvant	Dosage and route
1.	Haemorrhagic Septicaemia	Hs Vaccine	Animal Vaccine Institute, Gandhinagar	Inactivated *P.multocida* organism in alum precipated vaccine	5 ml S/C
		Raksha Hs	Indian Immunologicals	Formalin inactivated culture of *P. multocida* adjuvanted with aluminium hydroxide	2 ml S/C
		HS Vaccine	Brilliant	Inactivated *P. multocida* organism absorbed in aluminium hydroxide as an adjuvant	2 ml S/C
2	Foot & Mouth Disease	Raksha	Indian Immunologicals	Tissue culture inactivated FMD virus antigens O,A C and Asia I absorbed on to aluminium hydroxide and saponin added as an adjuvant	3 ml S/C
		Raksha –Ovac	Indian Immunologicals	Tissue culture inactivated FMD virus antigens O,A C and Asia I adjuvanted into mineral oil	2 ml I/M
		Bovilis Fmdv Gel	Intervet SPAH	Trivalent gel vaccine containing FMD virus O,A and Asia –I propageted in cell culture inactivated with BEI and absorbed with aluminium hydroxide gel with sapononin	2 ml S/C
3.	Brucellosis	Brucella Vaccine (Bruvax)	Indian imunological	Live *Brucella abortus* strain 19 bacteria in freeze dried powder	2 mlS/C
4.	Theileriosis	Raksha Vac-T	Indian immunological	Live schizont grown in lymphoblast cell culture, attenuated by prolonged in-vitro passage	3 ml S/C

Approaches For the New Generation Veterinary Vaccines

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"The practice of vaccination for the prevention of animal disease has been used for centuries and has proven to be a powerful tool for the alleviation of animal suffering as well as the economic well being of producers of animal products. Most of the current veterinary vaccines are based on the use of either killed organisms or their products or live attenuated organisms. The development of these vaccines has not relied on knowledge of the immune responses that mediate immunity. Significant advances have been made primarily by the development of new culture techniques, improved attenuation procedures and better adjuvants. While there is some scope for further efforts to develop vaccines along these lines, there are many diseases for which the more empirical methods are unlikely to be successful. The approaches used in the development of vaccines have expanded rapidly as the result of increased knowledge of the mechanisms by which protective immunity is induced, and the explosion of genomic data on both pathogens and their hosts. The associated evolution of new technology in the field of molecular biology and immunology has furthermore had a large impact on the development of new vaccine strategies and the quality of the products that are produced."

The aim of any vaccination policy in any species is to challenge the individual with a "controlled" dose of an immunogenic organism (bacterium, virus, mycoplasma, fungus, etc) in order to stimulate an immune reaction that will prime the animal's immune system to respond quickly and effectively to any future field challenge. Thus, vaccination is designed to prevent future disease. The advances in the knowledge about the immune response and molecular biology have allowed the identification of a large number of infectious agents and proteins of

immunological interest and their expression in different vectors of amplification. The elimination of those proteins that are not of immunological interest or are not related to the virulence of the agent is now possible. Thus, new vaccines have been created which do not contain the whole infectious agent and allows the serological discrimination between sick and vaccinated animals.

The basis of these new vaccines is, in the first place, the identification of the proteins of the infectious agent that are able to induce an immune response in a similar way to that produced by the whole agent. Secondly, the identification of those proteins that are not immunogenic, do not have a role in replication, or that are related to virulence. Using genetic engineering, the genes coded for these proteins can be selected, cloned and expressed using different vectors and they can also be eliminated by selective deletion. A variation of this system is the chemical production of the selected proteins once they have been identified. Another interesting aspect, when obtaining these new vaccines, is the possibility of incorporating the immunologically interesting proteins. These would be sequences of other antigens capable of increasing the stimulation of B and T lymphocytes, and even the release of cytokines.

Types of new generation vaccines

I. Inactivated proteins based vaccines

a) Subunit Vaccines by Recombinant DNA technique.

This technique is based on the production of proteins from an infectious agent without using the microorganism. Once the relevant proteins from an etiologic agent has been identified and sequenced, using genetic engineering techniques the DNA fragment codifying these proteins is isolated and then inserted into a plasmid that acts as the vector for the transference. Later, this is inserted in the expression vector. Large quantities of a protein (subunit) are produced (sometimes more than one protein is produced) and it can be used as a subunit vaccine. The most frequently used vectors for expression are bacteria, especially *E. coli*, yeasts and baculovirus. Baculovirus are being increasingly used for the production of subunit vaccines due to their great capability of expression. Baculovirus is an insect virus able to replicate in established insect cell lines using this system, different proteins against several animal viruses have been produced in insect cells: blue tongue disease, porcine parvovirus, and

African equine fever. In some cases, the production of several proteins at the same time simulating the virion particle ("Virus like particles" of VLP), has been possible. This is the case with blue-tongue disease; the obtained product has a high immunogenic capability.

b) Synthetic Vaccines by production of synthetic proteins.

In synthetic vaccines epitopes or antigenic determinants are identified in the complex structure of a protein Example in Foot and mouth disease the epitope is VP-1 protein which is located between amino acids 140 and 160, it is then possible to chemically synthesize them and then produce a synthetic peptide identical to that of the virus this is known as a synthetic vaccine. However, the number of protected animals (in the case of foot-and- mouth disease) is less than 50% of the total disease.

II. Live deleted vaccines

The genomic structure of some microorganisms has been modified to make live deleted vaccines. In this vaccine the genes that codes for the virulence proteins have been eliminated and so attenuated strains that are safe and stable can be produced example Aujeszky´s disease virus vaccine.

III. Live Recombinant Vaccines

Live recombinant vaccines are based on the use of a live microorganism (virus or bacteria) that acts as a vector for the expression of genes from another organism. The new recombinant microorganism can be used as a vaccine for both organisms.

a) Bacterial vectors

In general bacterial vectors are attenuated by deletion of genes required for key metabolic processes or genes associated for virulence. Although they are not used routinely in animals, rapid progress is being made in developing and evaluating different bacteria as vectors. For several years, BCG (Bacillus Calmette–Guerin) and *Salmonella* have been developed as vectors for delivering vaccine antigens to animals and the latter has been used for the generation of live vaccine strains for poultry. There are currently a number of other bacterial vectors being developed based on commensal microorganisms (*Lactococcus, Streptococcus,Lactobacillus* and *Staphylococcus*) or attenuated pathogenic organisms (*Shigella, Bacillus, Yersinia, Vibrio,Cornebacteria,* and *Bordetella*), all of which are being evaluated for their ability to induce protective immunity.

b) Viral vectors

Most viral vectors are developed using viruses that are associated with mild or no

disease or using viruses that are pathogenic but attenuated by deletion of virulence genes. Replication competent virus vectors, which can produce progeny virus, as well as replication-defective virus vectors, which do not produce progeny virus, have been developed and evaluated as vaccine delivery vehicles. A number of commercial vaccines based on DNA virus vectors, including poxviruses and herpesviruses, have been successfully licensed for use in veterinary medicine.

IV. DNA Vaccines

The fraction of DNA containing the gene of the protein able to induce an effective immune response has been identified, purified and inserted in a plasmid that acts as a vector. Animal cells capture these plasmids and then incorporate them into the cell nucleus, allowing the expression of the foreign gene and the production of the protein. This protein is released to the extracellular space, where it is recognized by the immune system in its natural form, just as happens during a field infection and induces efficient immune response.

V. Reverse Genetics vaccine

The development of a reverse genetics system for a range of different RNA and DNA viruses has revolutionized the field of virology by making it possible to introduce designed mutations, insertions and deletions into the viral genome of live viruses. It has by now been used in a range of applications that include the attenuation of viruses,the modification of host specificity and the generation of replication-deficient viruses. These strategies have also been applied to the development of new vaccine strategies and are widely used in the characterisation of the structure and function of individual viral genes and coding sequences. The technology of reverse genetics involves the generation of a cloned copy of complementary DNA (cDNA) from

RNA by reverse transcription *in vitro*, manipulating DNA *in vitro* followed by generating the modified live virus by transfection of permissive cells with the cloned DNA(s).

VI. Chimeric viruses vaccine

Chimeric viruses are defined as recombinant viruses that may contain parts of two closely related viral genomes. For example, a chimeric virus could be one that contains structural genes of one viral serotype and nonstructural genes of another serotype of the same virus. lternatively, a chimeric virus would be one that contains part of the genome from different members elonging to the same

virus family. In principle, chimeric viruses display the biological characteristics of both the parent viruses. One of the main advantages of this approach is that a single dose of chimeric virus delivers the complete repertoire of antigens closely resembling the pathogen(s), which can induce protective immune response against multiple viral pathogens belonging to or different serotypes of the same viral pathogen. New generation vaccines act upon the immune system in different ways depending on the type of vaccine. Subunit vaccines or vaccines based on synthetic proteins (inactivated proteins) act in a way similar to that of conventional inactivated vaccines, although usually more antigen is required to induce similar responses because they are less antigenic. The most important advantage of these vaccines is the lack of the entire infectious agent. This makes it possible to differentiate between vaccinated and sick animals. This characteristic is even more important in deleted live vaccines or recombinant vaccines, which being live vaccines, induce better immune responses than those of the inactivated proteins. DNA vaccines, consisting of a DNA fragment bound to a promoter, evoke both humoral and cell-mediated immunity. This type of vaccine seems very promising for future therapy. New generation vaccines solve some of the problems usually produced by the use of conventional vaccines

1. Discrimination between sick and vaccinated animals: This is one of the most important advantages of new generation vaccines compared to conventional vaccines. Example: In the case of Aujeszky´s disease, the use of gE-negative vaccines allows the implementation of eradication programs because the differentiation of sick from vaccinated animals is possible, vaccinated ones have only antibodies against gpII (not against gE) while carriers or sick animals have antibodies against both gE and gpII.
2. Cold chain: Sub-unit and synthetic vaccines do not require a cold chain as conventional vaccines.
3. Safety: Sub-unit or synthetic protein vaccines avoid the problem of incomplete inactivation that can be present in some of the inactivated conventional vaccines. These new generation vaccines do not need to be inactivated because they are made only of proteins. Deleted or recombinant vaccines also solve the problem of a potential reversion to the virulent form

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Preparation Of Different Meat Products

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"Meat is highly nutritious and versatile food. The primary importance of meat as a food lies in the fact that when digested its protein is broken down releasing amino acids; these are assimilated and ultimately used for the repair and growth of cells. Hence it is a source of high biological value protein. Meat production and consumption has increased remarkably in recent years in India. Demand for quality meat and meat products is increasing due to growing awareness about nutritional and sensory characteristics of meat products. Changing socio-economic status has also contributed for the enhanced consumption of processed and convenience meat products. As the demand for ready to eat meat products is ever growing due to rapid urbanization and industrialization, a lot of efforts need to be made to meet such increasing requirements. Variety of meat based products like tandoori chicken; pickles, balls/koftas, tikka, biryani, patties, nuggets and sausages are available in the market, Kashmiri products like goshtaba, rista as well as nate-yakhni have been reviewed."

Meat production and consumption has increased remarkably in recent years in India. Demand for quality meat and meat a products is increasing due to growing awareness about nutritional and sensory characteristics of such meat products. Changing socio-economic status has also contributed for the enhanced consumption of processed and convenience meat products. Though the meat industry in our country is yet to transform into an organized sector, its contribution to the national GDP has been significant. Meat and meat products during the year 2004-05 contributed Rs. 30,401 crores annually to the Indian economy (DAHDF, 2006). Ministry of Food Processing Industries has established National Meat and Poultry Processing Board to support the healthy and organized development of meat sector for clean and wholesome meat production. Further, Food Safety

and Standards Act, 2006 would regulate and ensure the processed meat sector to produce safe and quality products.

Meat plays an important role in the sustenance of human health and well being. The processing of meat products depending on the availability of raw materials, seasons and local taste preferences passes through generations with consequent improvement in sensory profiles. Among these foods traditional meat and poultry products are popular by virtue of their appealing sensory attributes and play pivotal role in human nutrition in India. Traditional meat and chicken based fast food products like *meat balls* (*koftas*), *kababs, tikka, chicken tandoori* (roast), *biryani, curries, pickles*, enrobed and battered products are attracting greater consumer response in India. *Goshtaba* and *rista*, popular traditional Kashmiri products are also being processed at fast food corners, restaurants, and hotels, etc and are liked by many for their unique taste. Many entrepreneurs have priority programmes on meat based fast foods to cater to the growing needs of younger generation. Venkey's India Ltd, Pune manufactures traditional chicken products such as *sausage, nuggets, patties,* and markets them in several cities. Small manufacturers have an advantage in the production of variety products with flexible processing systems. Consumer preferences have also shifted to different custom designed products from stereotype traditional foods supplied in bulk. Further developments in quality improvement, processing, consumption as well as demand, problems and prospects of meat and poultry products are discussed.

Ingredients

The ingredients can be classified in any one of the five categories viz., polysaccharides, proteins, fat and hydrogenated oil, water and seasoning.

Polysaccharides: Water soluble polysaccharides are long chain polymers that dissolve or disperse in water to give a thickening or viscosity building effect. These compounds serve diverse roles as providing hardness, crispiness, thickening quality, viscosity, adhesiveness, gel forming ability and mouth-fill. The functional properties of polysaccharides in batter are acquired by interacting themselves or with other ingredients such as proteins to provide stability and lipids to provide viscosity

and sometimes emulsifying action. Different flours such as Bengal gram, lentil, wheat and corn flour, starch, corn flakes have contributed better texture and crispiness to the enrobed products (Anjaneyulu *et al*., 2003; Keshri *et al*., 2003).

Proteins: Plant and animal proteins are widely used for enrobing meat and meat products. They include milk powder, milk protein fraction, egg albumin, skimmed milk powder, cereal flours, seed proteins etc. Non-fat dried milk has been used to

- Increases the water absorbing capacity of flour and viscosity of the system.
- Improves baking quality of meat product.
- Strengthens product texture and improve texture.
- Retard moisture loss.
- Enhance crust colour and flavour development.

Egg proteins form structure and act as thickeners. Seed proteins and soy proteins are widely used as enrobing ingredients because of their functional properties that improve emulsifying capacity, emulsion stabilization, fat and water absorption.

Fat and hydrogenated oils: They are rich source of fat-soluble vitamins and contribute to flavour and palatability as well as to the feeling of satiety after eating. Shortening contribute to the tender quality of a baked product by their lubricating action. Other fatty acid materials such as mono- and triglycerides and lecithin serve as emulsifying and staling inhibitors.

Water: It is used for making batter suspension and aid in the adhesion of beading to the surface of the product. This affects amount of coating on food, its thickness, machine ability and drying time. Water also acts in a structure-forming role by reacting with proteins and polysaccharides.

Seasoning: It includes sugar, salt, pepper, paprika and many other species, their use depends on the desired flavour. Sugar has plasticizing effect and provides flavour, either alone or in combination with amines. Salt enhances the flavour of foods. Some spices serve as antioxidants and provide specific flavours. Paprika gives a pleasing pink colour and is used where the products are to be frozen and heated in

microwave oven or baked under conditions where little browning occurs.

Types of batters

Conventional (non-leavened) batter: There are two primary types of conventional batters. One is wheat flour based batter, which mixes easily with water and apparently remains in a solution for long period of time. These materials are easily handled in mechanical batter applicator. Second type is corn flour based batter. It settles out easily and will change batter thickness resulting uneven pick-up. Continuous mixing is essential to keep solids in suspension when corn based batters are used (Cunningham, 1989).

Formulation for preparation of emulsion based meat products

Ingredients	Quantity (%)
Deboned meat	70
Fat/oil	10
Ice flakes/chilled water	10
Salt	1.6
Polyphosphates	0.4
Spice	1.6
Sodium Nitrite	0.01
Condiments	3.4
Maida	3

Tempura or leavened batter: These batters should not be pumped or re-circulated within the system. Continuous pumping or mixing allows CO_2 to escape and prevents the characteristic rise of the batter.

PREPARATION OF MEAT EMULSION OR BATTER

Meat and fat is freezed to about at -18±1^{0}C then thawing the meat at 4±1^{0}C for 12 hrs. the chilled meat is then chopped in grinder to desired consistancy. Mincer machine meat chunks of variable size and shape and with variable fat contents are ground to form uniform cylenders of fat and lean. The worm or screw feed in the barrel of grinder convey the meat and passes it into the barrel of grinder plate. The ratating blade cut the compressed meat and aids in fillilg plate holes. Ice cube are added to produce proper texture and insure a low meat temperature during mincing. The operations are performed at a temperature 10^{0}C-15^{0}C so that meat emulsion will not break. Spice, curing ingredients like sodium or potassium nitrate, sodium cloride, sometime sugar, ascorbates etc. may be added to the grinder or latter in meat

mixture machine. (Anjaneyulu *et al.,* 2003).

PREPARATION OF NUGGETS

Fill the meat batter in aluminum moulds and provide steam cooking the meat blocks for 40 minutes. Chill the meat blocks at 4±1^{0}C overnight then cut with food slicer into nuggets then Packaging in LDPE bags and Stored at 4±1^{0}C or -18±1^{0}C. (Altunakar, B., Sahin, S. and Sumnu, G. 2004).

PREPARATION OF PATTIES

About 70 g meat batter filled in the Petri plates/ automatic patty forming machine. Raw patties kept on perforated oven trays and load in preheated (180 ^{0}C) the hot air oven.Turn upside down after 15 minutes further heating in oven for 10 minutes then record core temperature of patties (should be above 75 ^{0}C) remove the patties from oven packaging in LDPE bags and Storage at 4±1^{0}C or -18±1^{0}C (Biswas, A. K., Keshri, R. C. and Chidanandaiah 2005).

PREPARATION OF MEAT BALLS/KOFTA

About 20-30 g meat batter formed in to round balls. Cooked in the hot water and record core temperature of meat balls (should be above 75 ^{0}C). Meat ball will Package in LDPE bags and Storeat 4±1^{0}C or -18±1^{0}C.

PREPARATION OF CROQUETTES

About 8-10 g meat batter in small lumps put it in preheated oil With deep fat frying till golden brown appearance Drained off excess of fat. Packaging and Storage at 4±1^{0}C or -18±1^{0}C

PREPARATION OF CURED AND COOKED HAM

Recipe

Sr. No.	Ingredients	%	Quantity
1	Trimmed ham (From hind leg of pork carcass)		1 kg
2	Dry Cure mixture		
	a. Salt	8	80 g
	b. Sugar	5	50 g
	c. Sodium nitrate	0.017	0.17g

Protocol

Trim ham, divide cure mix in to 3 parts and rub cure mix one part on flesh and skin side then rub second part after 24 hours. Keep the ham in the refrigerator (at 5-7 ^{0}C, relative humidity 80-90%) and then rub third part after 24 hours. Keep the ham in the

refrigerator (at 5-7 ^{0}C relative humidity 80-90%). Keep for maturation at the rate of one day for 2 kg weight. Desalinate ham in by soaking the cured ham in warm water (35-40 ^{0}C) for 2 hours to remove excess of salt and drain. Cook in the preheated oven or Smoke at 65^{0}C for 24 hours. Wash and draining then ageing is done for 24-48 hrs (at 5-7 ^{0}C, relative humidity 80-90%).

Kababs

Variety of *kababs***,** popular convenience and nutritious comminuted meat products made either from mince or chunks of meat and other ingredients vary in appearance and flavour. *Kababs* are a dish of oriental origin, prepared in several countries by charbroiling. The flavour of charbroiled kababs is unique due to combustion of fat that drips on the red hot charcoal. Oven roasting is generally used for commercial scale cooking of many meat and poultry products. Charbroiling is done at 230 ± 2^{0}C for 3 min (internal temperature 75 ± 2^{0}C) while oven roasting is carried out at 180 ± 2^{0}C for 12 min (internal temperature 75 ± 2^{0}C). Meat cooked quickly to a given internal temperature has a lower cooking loss, and is juicier than those cooked slowly to the same temperature. Charbroiled *kababs* are characterized by better appearance (browning), flavour (smoked), juiciness and texture and more yield than oven roasted ones (Mir Salahuddin *et al.,* 1991). However, due to its convenience, the oven roasting may be more suitable for commercial production of *kababs*. Emulsion technology has been developed for processing of high yielding and palatable mutton and chicken *kababs* from meat and byproducts of spent hens utilizing polyphosphate, soy, potato and maida as binders (Mir Salahuddin *et al.,* 1991). Chicken *kababs* have greater consumer acceptance than mutton kababs. However, incorporation of spent hen meat and byproducts in mutton kababs formulations improved the products yield and consumer preference (Mir Salahuddin *et al.,* 1991). Further shelf life evaluation showed that precooked charbroiled *kababs* from chicken, mutton and their combination has good acceptability for a period of 10 days during refrigerated storage at 5 ± 1^{0}C. Garlic *kababs* are made from chicken breast or leg chunks. Breast chunks are marinated, inserted with an ingot skewer (iron rod), placed in a preheated

oven and baked. Optimum process for garlic kababs is reported to bake the products for 15 min at 250^{0}C after marinating for 60 min (Rao, 1996).Traditional ginger *kababs* and *shami* kababs simulating chicken meat products of high sensory quality are prepared from rabbit meat. Freshly prepared *boty kababs* of rabbit meat (boneless pieces grilled) are rated significantly higher ($P<0.05$) for juiciness, tenderness and overall acceptability than mutton *boty kababs* (Sushil Kumar *et al.,* 1997a). Further, these products are reported to be acceptable and safe up to 5 days of refrigerated storage. Colour and tenderness of buffalo meat *kababs* are improved by microwave cooking than broiling in hot air oven (Hoda *et al.,* 2002). Dehydrated chicken *kabab mix* packed in metalised polyester pouches has microbiologically safety for 6 months at ambient temperature of 27 ± 2^{0}C and *chicken kababs* prepared from dehydrated mix are acceptable after 6 months of storage (Modi *et al.,* 2007).

Different types of *kababs* have been made at functions, restaurants and star hotels and served them warm to the consumers. Small scale meat processors like M/s Darshan Foods, Gurgaon, manufacture *kababs* and supply to departmental stores and hotels in Delhi. *Kababs* are relished by most of the meat consumers as snack food.

Tandoori chicken

It is a value added popular product made from marinated tender broiler chicken and relished by majority of consumers. Small superficial incisions are made on the deskinned primal cuts or carcasses to facilitate the penetration of marinade (for 2 h) and smeared salt and lemon juice for 15 min and baked in a gas tandoor. Finished product is cut into primal cuts and served warm. Processing of *tandoori* chicken using response surface methodology has indicated that optimum period of marination is 120 min and processing time is 20 min at 280^{0}C (Rao, 1996). Cooking temperature and time positively influence the sensory attributes such as colour, juiciness, texture and taste of the product. Though quality of he *tandoori* chicken is stated to be optimum immediately after processing it can be stored for 8 h at 30^{0}C, 24 h at 3^{0}C and for 15 days at -15^{0}C in microbiologically safe conditions

(Rao, 1996). The main processing factors such as time, temperature and marination lowered the total microbial load. Apart from enhancing some of the sensory attributes of the products, the marinating mixture acts as a bacteriostatic agent as well as a barrier for other harmful microbes contaminating the product. Further, increase in temperature and time of cooking has considerably reduced the microbial counts and eliminated the pathogens resulting in a safe product (Rao, 1996). The demand for *tandoori* chicken is ever increasing among younger generation.

Korma

Medium size washed mutton or chicken meat pieces are drained off excess water and marinated with salt, spices, condiments and curd for about 4 h. Sufficient quantity of *ghee*, chopped onion, bay leaves and *garam masala* are fried. The marinated meat pieces are blended with spice preparation and cooked under heat till the visible moisture from the meat is evaporated. Then it is added with curd and little sugar and placed under low flame till meat is completely cooked (Kesava Rao *et al.,* 1999). Mutton and chicken *korma* are popular products and have potential for commercial production in retort pouches for wider distribution and marketing.

Goshtaba and rista

These are two popular pounded ground meat products of Kashmir valley, 'Wazawan' and also processed in other major cities. Wazawan represents the entire range of highly delicious Kashmiri meat products viz. *goshtaba, rista, nate-yakhni, tabak manss, aba gosh, roganjosh* etc are made mainly using mutton or lamb. These products are processed traditionally from hot boned (pre-rigor) tender mutton. *Goshtaba* and *rista* consist of specially pounded meat balls shaped manually from the meat batter and cooked in their respective gravies. It is made by continuous pounding of hot boned mutton along with mutton fat using indigenous equipments. *Goshtaba* meat balls are cooked in gravy called *yakhni* made from curd, water, spices and condiments. They differ mainly in flavour profile due to basic differences in formulations of gravy. *Goshtaba* and *rista* are considered to be essential components for Kashmiri feasts due to

their highly appealing flavour, texture and palatability characteristics. Because of their popularity, there is a vast potential to introduce them at the national level and to promote their export. Quality of traditionally processed *goshtaba* and *rista* are reported to be superior to that of machine minced products. Addition of 0.5% sodium tripolyphosphate along with 2.5% salt improves the palatability, when these products are made from minced meat of cold- boned mutton. The cooked goshtaba and *rista* along with respective gravies packed in LDPE pouches have a reported shelf life of 7 and 4 days, respectively on refrigerated storage.

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Role of Probiotics in the Control of Necrotic Enteritis in Poultry

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"Necrotic enteritis caused by Clostridium perfringens is an acute disease of 2-4 weeks old broiler chickens, producing high mortality. The disease is routinely controlled by antimicrobial drugs, antibiotic growth promoters and ionophores anticoccidials. But this practice has recently come under greater scrutiny due to rise and spread of antibiotic resistant bacterial strains. Thus, suitable alternative prophylactic measures against NE have been warranted. In the present study, role of probiotics in the control of NE is explored."

Poultry production in India has become increasingly specialized and integrated into a dynamic industry of major national and international importance. Poultry production has played a pivotal role in increasing source of income and employment generation for the educated unemployed youth. To achieve high levels of economic efficiency, poultry are raised under intensive system in densely populated flock. Due to the intensification, the birds face lots of stress, which lead to imbalance in the intestinal microflora and lowering of body defense mechanisms, making them vulnerable to many diseases. Among the prevailing pathogens, intestinal pathogens are a major cause of death, disease and poor performance in poultry. *Clostridium perfringens* is one of such pathogens causing necrotic enteritis in poultry. Necrotic enteritis (NE) caused by massive proliferation of C*. perfringens* in the small intestine of the chicken has been a persistent problem in commercial poultry, especially in rapidly growing broiler chickens. It is an acute disease of 2-4 wk old broiler chickens, causing high mortality and poor feed conversion ratio. Normally, the number of *C. perfringens* in the intestine is low (about 10^4 cfu/g of digesta).

The disease occurs when high numbers of bacteria coincide with a damaged intestinal mucousa (Alsheikhly and Truscott, 1977). The disturbances in normal intestinal microfolora may cause rapid proliferation of *C. perfringens*,

increasing bacterial numbers the range from 10^7 to 10^9 cfu/g of digesta resulting in toxin production (Kondo, 1988). Necrotic enteritis is routinely controlled by incorporation of antimicrobial drugs, antibiotic growth promoters and ionophore anticoccidials. Johnsson *et al.* (2004) reported that all strains, regardless of origin, proved inherently susceptible to ampicillin, narasin, avilamycin, erythromycin and vancomycin. In spite of these, considering the public concern about the threat of antibiotic resistant pathogens, the European Union banned avoparcin in January, 1997, Ardamycin in January, 1998 and further four antibiotics bacitracin, virginamycin, tylosin and spiramycin in December, 1998. Ban of remaining antibiotics and antibiotics growth promoters may be in the near future (Immerseel *et al*., 2004). The use of coccidiostats of ionophore type, which is one of the main tools to control NE are also forbidden in the year 2012. Unfortunately, due to the withdrawal of antimicrobial drugs, antibiotic growth promoters and ionophore anticoccidials, NE is expected to become more widespread. This phenomenon has already been observed in several poultry raising countries, where restrictions and limitations on the use of growth promoting and prophylactic antibiotics in chicken feed have led to an increase in the prevalence of NE (Wise and Siragusa, 2005). Hence, possible alternate strategies for control of NE in the 'post – antibiotic' were suggested. This includes probiotics, prebiotics, organic acids, enzymes, hen egg antibodies, bacteriophages and vaccination. (Dahiya *et al*., 2006). The term direct-fed microbials or probiotics has been defined as a "live microbial feed supplement which beneficially affects the host animal by improving its intestinal microbial balance" (Fuller, 1999). Probiotics are intended to modify the gastrointestinal microflora in such a way that bacterial activities advantageous to the host are stimulated and those adverse to the host health are suppressed (Netherwood *et al*., 1999; Simmering and Blaut, 2001).

A number of studies have reported a potential benefit of culture of caecal material on NE in broiler chickens including reduced mortality and reduced caecal colonization of *C.perfringens* (Elwinger et al., 1992). Hofacre *et al*. (1998) challenged broiler chickens experimentally with *C. perfringens* and observed that normal gut flora products reduced gross intestinal lesions and improved feed efficiency in broiler chicken. Craven *et al.* (1999) reported a

reduction in *C. perfringens* colonization and decreased incidence of necrotic enteritis in chickens treated with normal gut flora, together with increased slaughter yield. In a field study, Kaldhusdal *et al.* (2001) found that post-hatch use of flora prepared from adult birds was associated with delayed intestinal proliferation of *C. perfringens*, delayed appearance of NE gross lesions and better production performance at slaughter. Maintenance of a stable gut flora was essential to prevent dysbacteriosis, a general overgrowth of the intestinal microflora, which may predispose to NE by reducing oxygen tension to a level favourable for *C. perfringens* proliferation (Schuring and Gills, 2001)

Studies regarding the protective effects of probiotic strains against *C. perfringens* in chickens are limited. Fukata *et al.* (1988) and Fukata *et al.* (1991) reported a very low mortality in chicks inoculated with *L. acidophilus* or *S. faecalis* and then challenged with *C. perfringens* compared with a 50 per cent mortality rate in germ free chicks and no mortality in conventional birds. They also observed a suppression of alpha toxin production when chick intestinal contents were cocultured with *C. perfringens*. Hofacre *et al.* (1998) observed that a commercial probiotic product reduced gross lesions of necrotic enteritis in chickens, but the protection was far less than that conferred by a normal gut flora preparation. Mortality due to necrotic enteritis was significantly reduced from 60 to 30 per cent in experimentally challenged broilers when they were treated with a defined lactic acid bacterial culture at day 1 of age (Hofacre *et al.,* 2003). In this experiment, feed conversion was decreased in the group that was given lactobacilli, but weight gain was not affected. La Ragione and Woodward (2003) reported that when chickens of 1 and 20-day-old were challenged with 10^9 spores of *Bacillus subtilis* strain and infected 24 h later with 10^5 cfu of *C. perfringens*, colonization and persistence of *C. perfringens* was suppressed. Boobalan, (2006) reported that addition of probiotics in the feed resulted in increased weight gain, reduced mortality and reduced *C. perfringens* count in the intestine on NE induced birds.

Reports of immunomodulation effect of probiotics against NE are scanty. However, immunomodulation effect of probiotics for other pathogens is available. Koenen et al. (2004) reported that Lactobacillus strain has different effect on the GI tract and immune system depending on the type, genetic-make up

and age of the chicken. Though the magnitude of the effects per animal is limited, non specific enhancement of the immune system might support health of the flock in a very inexpensive way. Better effect of multistrain probiotics than single strain probiotics on immune response of broiler chicks vaccinated against avian influenza virus (Ghafoor et al., 2005). Kannan et al. (2005) reported that dietary supplementation of *L.sporogenes* had significantly improved the immune response against Ranikhet disease in broilers at 28 and 49 days of post vaccination.

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Care and Management of Orphan Camel Calves

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Camel calves usually become orphan either due to death of dam during parturition or sale of dam. Orphan camel calves will have low survival rates unless they have drunk colostrum and can sit up and stand. A normal, healthy camel calf can stand and suckle within two hours after birth. Most will walk within five hours and be strong enough to follow their mother within two days after birth. Therefore special attention should be provided towards orphan camel calves.

Fostering

Fostering onto a lactating camel cow is the first option for an orphan camel calf. For the fostering to be successful, the calf's 'new' smell must be hidden from the cow and the calf must freely drink milk from the cow's udder. This process can be achieved by first restraining the camel cow and orphan calf, in order to wipe a strong-smelling, apply non-toxic substance such as fish oil over both the cow's nose and the calf. This will block the ability of the cow to detect the orphan calf's new smell. Next the foster camel cow should then be left alone with the orphan calf for a day to let the calf drink.

Hand-feeding

Hand-feeding is the second option for an orphan camel calf. This can be done with one of the following:

- Colostrum collected within the first three days of lactation from camels, goats or cattle
- Milk collected from camels, goats or cattle
- Customised colostrum or milk replacers; or
- Commercial colostrum or milk replacers.

Hand-feeding routine

- Initially hand-feed fresh colostrum, milk or replacer at body temperature with a large rubber calf teat. This ensures that the camel calf receives milk at an adequate temperature and flow rate.
- After the first couple of weeks, room temperature milk is satisfactory.

- Refrigerate excess colostrum or milk replacer and always keep the feeding equipment clean.
- In general, feed ½ litre of milk or replacer four times during the day and twice during the night.

Build up the amount of each feed and reduce the frequency to twice a day by four months of age. By this time, weaning onto solid feed has commenced.

The diseases or health hazards of camel calves

Vaccination and treatment against viral diseases like camel pox, rinderpest and bacterial diseases like anthrax and pulmonary-affection-complex helps to prevent losses due to diseases.

Tick infections and their control

Ticks are killed by spraying, removing by hand or applying kerosene or a lighted cigarette to the back of the tick. Infections can be controlled by pasture rotation. Tick paralysis can be caused by the bite of a single tick. The only treatment for paralysis is to quickly find and remove the tick. If this is done quickly enough the animal will eventually recover.

Problems caused by fly maggots

Fly maggots can prevent healing of wounds and other germs may infect the wound. The maggots of the camel nasal fly are usually seen in the spring and summer. Maggots should be removed from wounds and the wound properly cleaned and dressed. The maggots of the nasal fly can be killed by giving injections of nitroxynil but this need only be done if veterinary officer advises it.

Ringworm infection of the camel calves

It is infectious and will spread to other animals and can infect humans. Ringworm is treated by applying tincture of iodine. Test the Skin scrapings to discover if the problem is caused by mange or ringworm.

Table 1: The development and needs of orphan camel calves

Age of camel calf	Approximate weight of camel calf	Note	Comment
Newborn (birth to 5 days)	35 - 40 kg	Navel cord is not yet shrivelled.	Feed colostrum or replacer up to 8 times per day. Provide clean, dry, quiet shelter and check that: • naval cord is clean and dry (*disinfect if still moist*); • Urination and defecation are problem free.
Young (1 week to 2 months)	40 - 70 kg	Navel cord is shrivelled.	• Feed milk or replacer, reducing from 8 to 4 times per day. • Provide clean, dry, quiet shelter. • Provide a companion animal.
Growing (2 to 4 months)	70 - 110 kg	Calf still drinks milk and starts eating solid feed.	• Feed milk or replacer 4 times to once per day. • Feed high quality, high protein solid feed. • Provide clean, dry, sheltered pen. • Provide a companion animal if possible.
Weaner (4 to 9 months)	110 - 150 kg	Calf drinks less milk and eats more solid feed.	Wean onto high protein solid feed e.g. lucerne hay, topfeed. Yard with other camels.

Table 2: Guide to the amount of milk to feed to orphan camel calves

Age of camel calf	Approximate weight of camel calf	Number of feeds per day	Maximum amount per feed
up to 1 week	40 kg	up to 8 (initially colostrum, 2-hourly)	¾ litre
2 to 4 weeks	50 kg	6 (4-hourly)	2 litres
up to 2 months	70 kg	4 (6-hourly)	3½ litres
up to 3 months	90 kg	3 (8-hourly)	4½ litres
up to 4 months	110 kg	2 (12-hourly)	3½ litres
up to 5 months	130 kg	1 (24-hourly)	3½ litres

Table 3: Camel colostrum replacers

Replacer #1 camel, cattle or goat colostrum. **Replacer #2** commercial colostrums. **Replacer #3** (recipe for 1 litre) 600 mL cattle or goat milk; 300 mL clean water; 1 whipped egg; 5 mL paraffin oil (*or* 5 - 10 g charcoal); 10 - 15 g diarrhoea salts/ electrolytes; 10 - 20 g glucose; vitamin B and C; 10 mL plain yoghurt.	**Replacer #4** (recipe for 1 litre) 1L commercial cattle or human milk replacer (as per manufacturer's directions); 5 mL paraffin oil (*or* 5 - 10 g charcoal); 10 - 15 g diarrhoea salts/ electrolytes; vitamin B and C; vitamin A and D drops (as per manufacturer's directions); 10 mL plain yoghurt. * Use 'colostrum replacers' up to day 5 of life. * Fresh colostrum can be collected and frozen, then thawed and carefully warmed to body temperature when needed. * For extra immune protection, add 50 mL of camel serum to these 'colostrum replacer' recipes.

Table 4: Camel milk replacers

Replacer #1 (recipe for 1 litre) 500 mL cattle milk; 500 mL skim milk; 10 - 20 g glucose; 50 g skim milk powder; 10 mL plain yoghurt. **Replacer #2** (recipe for 1 litre) 1 L goat milk; 50 g skim milk powder; 10 mL plain yoghurt.	**Replacer #3** (recipe for 1 litre) 1 L commercial cattle milk replacer (as per manufacturer's directions); 10 - 20 g glucose; 50 g skim milk powder; 10 mL plain yoghurt. ** Use 'milk replacers' as early as day 3 of life. ** To improve calf growth rate, increase skim milk powder to 500 g in these 'milk replacer' recipes.

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Recent Development of Vaccination in Fish

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Aquaculture has been globally recognized as the fastest growing food production sector (FAO). The intensive farming of finfishes and shellfishes has led to an imbalance of best culture conditions that shows enhanced susceptibility to infectious disease. Increased incidence of microbial diseases in aquaculture system is the major obstacle within the success of the business. Use of antibiotics has attracted lot of criticism as a result of the problems like antibiotic residues, bacterial drug resistance and toxicity. In this present scenario, vaccination would be the best alternative to combat bacterial and viral disease for the sustainable aquaculture. The primary report on fish vaccination was by David C. B. Duff and he is regarded as "Father of fish vaccination". It is standard that the appearance and development of a fish disease process is the result of the interaction between infectious agent, host, and environment. Therefore, only multidisciplinary studies involving knowledge of the characteristics of the potential pathogenic microorganisms for fish, aspects of the biology of the fish hosts, moreover as a better understanding of the environmental factors affecting them, can enable the appliance of adequate measures to stop and management the most diseases limiting the production of freshwater and marine fishes. Regarding the infectious fish diseases caused by microorganism, though pathogenic species are described within the majority of the present taxonomical groups, only a comparatively small variety are responsible for necessary economic losses in the extensive cultures worldwide.

Vaccination is becoming a more and more vital a part of aquaculture, since it is considered a cost effective method of

controlling different threatening diseases. The term vaccination strategy has been defined to include the decision as to which diseases to vaccinate against, as well as the vaccine type, vaccination method, the timing of vaccination and the use of revaccination. Aquaculture still faces serious economic impacts as a result of the loss of animals to disease. A conservative estimate of 5% losses as a result of disease means that the finfish aquaculture business loses over $1 billion annually on a global scale. One proven way to prevent expensive disease outbreaks is to immunize fish against common or identified pathogens. Current vaccination schemes still result in losses, however, and this might be due in part to immunizing agent design. Vaccines are presently designed using state of the art knowledge of immune responses that is predicated totally on mammalian studies. One necessary thought for development and exploitation of vaccines includes the applying strategies and procedures that can be integrated into the normal production protocols of the target fish species that are relevant to the standard ecology and epidemiology of the disease (i.e. seasonal incidence, fish size, host and geographic range of the disease).

CONCEPT OF VACCINATION

Vaccination could be a most effective technique of protective fish from diseases. Vaccination could be a method by that a protective immunologic response is start in an animal by administration of vaccines. Vaccines are preparations of antigens derived from infective organisms, rendered non-pathogenic by various means, which can stimulate immune system of the animal to extend the resistance to the disease on natural encountered with pathogens. Once stimulated by a vaccine, the antibody-producing cells, known as B lymphocytes, stay supersensitive and prepared to respond to the agent should it ever gain entry to the body.

IMPORTANCE OF VACCINATION

- Vaccines are not a similar as antibiotics and usually won\'t be effective for stopping a disease outbreak once it's begun.
- Vaccines are used to stop a specific disease outbreak from occurring and are not a therapy.
- Its efficiency exists for a longer duration with one or more treatments.
- No cyanogenetic side effects and healthy fish have higher growth performance.
- No accumulation of toxic residues

- Pathogen won't develop resistance.
- Theoretically it can management any microorganism and viral disease.
- No environmental impact.

PROPERTIES OF THE IDEAL VACCINE

- Is safe for the fish, the person(s) vaccinating the fish, and therefore the consumer;
- Protects against a broad strain or microorganism sort and provides 100% protection;
- Provides long-lived protection, a minimum of as long as the production cycle;
- Is simply applied;
- Is effective during a variety of fish species;
- Is cost effective; and
- Is readily licensed and registered (Grisez and tan 2005).

TYPES OF VACCINES

The optimum way of development of an effective vaccine entails the identification of the key virulence factors. Further, the induction of the reaction should be optimized in order that the vaccinated animal develops a protecting immunity against the pathogen. So far, most vaccines employed in aquaculture are developed through associate empirical process, the main points of which are able to be which will within the ensuing paragraphs.

1) Inactivated Vaccines

Bacterins with antigens of Gram-negative organisms such as Vibrio anguillarum, Vibrio ordalii, Vibrio salmonicida and Yersinia ruckerii have been produced by broth fermentation and subsequent formalin inactivation. Administration is by injection or immersion. Provided that the serotypes used for vaccine preparation cover the field strains and that the vaccines are used correctly, these vaccines are effective and give negligible side effects (Stevenson, 1997; Toranzo et al., 1997). For some diseases, including infections with Aeromonas salmonicida subsp. salmonicida, an acceptable level of protection can only be achieved by immunisation with adjuvanted bacterins that are delivered by injection (Ellis, 1997; Midtlyng, 1997). Most vaccines used in aquaculture to date have been inactivated, bacterial vaccines. However, during recent years, inactivated virus vaccines against infectious pancreatic necrosis (IPN) in Atlantic salmon and grass carp haemorrhage disease have been used with some success (Dixon, 1997).

2) Live Vaccines

Live, attenuated vaccines should potentially have many advantages in aquaculture

(Benmansour and de Kinkelin, 1997). Vaccination with a live vaccine is in reality an infection (with an attenuated strain), and if the vaccine strain is shed by vaccinated fish, an effective dissemination of the antigen in the population would take place over an extended time period. Live vaccines also have the advantage that they stimulate the cellular branch of the immune system (Marsden et al., 1996). Finally, attenuated vaccines have some economic advantages in terms of simple delivery and low dose requirements due to multiplication in the fish. Some of the live vaccines tested experimentally elicit protective immunity, which is comparable with that of inactivated vaccines against the same microorganism (Marsden et al., 1998). However, live vaccines for fish are used under natural conditions and consequently, the requirements for documentation of the risks of reversion to virulence and uncontrolled environmental spreading should be emphasized. Although scientific risk assessments of using live vaccines have not been presented, there seems to be a general view that the risks associated with live vaccines in aquaculture, whether produced by conventional methods or by recombinant techniques, should be scrutinized. Live, attenuated vaccines have so far only been allowed for field trial purposes in the catfish industry in the US.

3) Vaccines based on DNA

In recent years, various vectors have been used for cost-effective production of sufficient quantities of protective antigens by recombinant DNA technology. In aquaculture, research on recombinant vaccines has focused on viral vaccines. Glycoproteins of the viruses causing viral hemorrhagic septicemia (VHS) and infectious hematopoietic necrosis (IHN) in rainbow trout elicit production of moderate levels of protective, neutralizing antibodies under experimental conditions (Lorenzen *et al.,* 1993). These glycoproteins have been expressed in Escherichia coli, and more recently in attenuated strains of A. salmonicida (Noonan *et al.,* 1995). So far, the only licensed recombinant fish vaccine is for protection against IPN (Frost and Ness, 1997). The VP2 sequence is expressed in E. coli producing an rVP2 peptide that induces production of a-IPNV specific antibodies (Christie, 1997). The adjuvanted recombinant vaccine is given by injection to pre-smolts.

Genetic immunisation using naked DNA is the most recent approach in vaccine design (Babiuk et al., 1996). This technology is based on the observations

that skeletal muscle cell injected with purified plasmid DNA express plasmid-encoded proteins. In mammals, experimental DNA vaccines have been used successfully in immunisation experiments with several important viruses including influenza virus and rabies virus. In fish, injection of plasmid DNA containing genes encoding glycoproteins or nucleocapsid protein, protected against challenge by IHN (Anderson *et al.,* 1996) and VHS (Lorenzen *et al.,* 1998). DNA vaccines have advantages over conventional vaccines. In mammals, the specific immune response after DNA vaccination encompasses antibodies, T-helper cells, as well as cytotoxic cells. However, before DNA vaccines are applied in commercial enterprises in aquaculture, safety for fish, environment and the consumer have to be addressed. As the DNA-sequence encodes only a single viral gene, there should be no possibility of reversion to virulence, which is a critical factor in relation to environmental safety in aquaculture.

4) Biofilm vaccines

Bacterial biofilm is a colony of high density of cell embedded in a glycocalyx matrix on a substrate, which has been demonstrated to be resistant to action of antibiotics chemicals and host immune system. Bacteria biofilm on suitable substrate after inactivation can be used as a successful oral vaccine.

5) Recombinant protein vaccines

It starts with identification of immunogenic subunit or protein from a pathogen of interest followed by the genes involved in coding for them which can be introduced into a vector, over expressed in expression hosts and can be used as recombinant protein vaccines.

VACCINES AGAINST SOME FISH DISEASES

(i) Bacterial vaccines

Antigens from V. anguillarum, V. ordalii and V. salmonicida have been used for a long time in fish vaccines (Toranzo *et al.,* 1997). These microorganisms cause diseases that in their classical form are a septicaemia. V. vulnificus and V. viscosus present new challenges for the fish vaccinologists, the former being an opportunistic human pathogen and the latter causing `winter ulcer' in Atlantic salmon, which severely affect the commercial value of the fish. An inactivated vaccine against V. viscosus has been shown to give protection (Vinitnantharat et al., 1999). So far, no commercial vaccine containing V. vulnificus antigens is available, but a toxoided bacterin with Spanish and Japanese strains has been shown to be protective both in

laboratory experiments and in commercial farms (Toranzo *et al.,* 1997). The successful use of immunoprophylaxis to prevent furunculosis caused by A. salmonicida subsp. salmonicida in salmonid fish suggests that diseases caused by atypical A. salmonicida can also be controlled by vaccination. Atypical A. salmonicida has been isolated from salmonids and non-salmonids in fresh water as well as in marine environments all over the world (Wiklund and Dalsgaard, 1998). So far, successful vaccination has been reported from Iceland where injectable, adjuvanted vaccines based on A. salmonicida subsp. achromogenes were found to induce the production of antibodies and provide protection against atypical furunculosis in salmon (Gudmundsdottir *et al.,* 1997). Extracellular enzymes, capsular polysaccharides, LPS and iron regulated outer membrane proteins are among the factors proposed to be important for the virulence of Pasteurella piscicida (Romalde and Magarinos, 1997). Vaccines covering some of these virulence determinants are now being introduced in several Mediterranean countries (Gravningen *et al.,* 1998). The severe losses due to enteric septicaemia of channel catfish caused by Edwardsiella ictaluri have generated considerable activity in the scientific community, but so far with no solution for the affected industry. Neither immersion nor oral preparations with inactivated antigens provided protection against infection with this facultative intracellular pathogen (Shoemaker and Klesius, 1997; Thune *et al.,* 1997). An injectable vaccine gave a low, but significant protection (Thune et al., 1997), whereas a preparation with live attenuated microorganisms was found to stimulate antibody production, macrophage-mediated killing, as well as protection in challenge experiments (Shoemaker and Klesius, 1997). Among diseases caused by Gram-positive bacteria, enterococcosis (streptococcosis) is the best candidate for successful vaccine development. This group of diseases is caused by several species of microorganisms which recently have been reclassified taxonomically using molecular tools (Bercovier *et al.,* 1997). Preparations with inactivated bacteria given intraperitoneally were found to stimulate protective immunity in turbot, rainbow trout and tilapia (Toranzo *et al.,* 1995; Akhlaghi *et al.,* 1996; Bercovier *et al*., 1997).

(ii) Viral vaccines

Antigens produced by several viruses administered by injection or immersion

have been shown to elicit protective immunity. However, for several viral diseases including VHS, IHN, spring viraemia of carp and channel catfish virus disease, the level of protection has been too low for commercial use (Dixon, 1997; Lorenzen and Olesen, 1997; Winton, 1997). Vaccines against IPN with antigens from inactivated virus or produced by recombinant technology, respectively, are in common use in Norway (Frost and Ness, 1997). Administration of adjuvanted preparations by injection is a prerequisite. However, protection is not well-documented.

Vaccination against grass carp haemorrhage disease with live or inactivated vaccines reduces mortality significantly. An inactivated, non-adjuvanted vaccine for parenteral administration is produced commercially in China (Dixon, 1997). Red sea bream iridoviral disease is a threatening condition for Japanese marine aquaculture. Red sea bream immunised with inactivated iridoviral antigens were significantly better protected than non-vaccinated fish after experimental infection (Nakajima *et al*., 1997).

(iii) Parasitic vaccines

There are not any commercial vaccines against parasitic diseases in fish. However, throughout recent years studies on the mechanisms of response to totally different parasites are performed (Secombes and Chappell, 1996; Woo, 1996). One amongst the candidate diseases for immunoprophylaxis is cryptobiosis. In rainbow trout vaccinated with a live Cryptobia salmositica vaccine, complement fixing antibodies were demonstrated and also the vaccinated fish showed protection once challenged with the infective haemoflagellate (Li and Woo, 1997).

The great challenge is to regulate salmon louse (Lepeophtheirus salmonis) infection by vaccination. The success with vaccination against Boophilus tick infections in cattle provides hope for a similar strategy against ectoparasites of fish. tries are created to identify enzymes of importance for digestion of put in sea lice internal organ, however vaccination studies supported these antigen preparations have so far not proven successful (Roper et al., 1995).

List of fish vaccines developed

VACCINES	SPECIES	DISEASE
Aeromonas salmonicida Bacterin	Atlantic salmon	Furunculosis
Vibrio anguillarum-Ordalii-*Yersinia ruckeri* Bacterin	Rainbow trout	Vibriosis, yersiniosis (enteric red- mouth disease)
Yersinia ruckeri Bacterin	Salmonids	Yersiniosis (enteric red-mouth disease)
Vibrio salmonicida Bacterin	Salmonids	Vibriosis
Vibrio anguillarum-salmonicida Bacterin	Salmonids	Vibriosis
Aeromonas salmonicida Bacterin	Salmonids	Furunculosis
Edwardsiella ictaluri Bacterin	Catfish	Enteric septicaemia
Spring viraemia of carp virus	Common carp	Spring viraemia of Carp
Koi herpes virus (KHV)	Koi carp	Koi herpes virus (KHV) disease
Biofilm and free-cell vaccines of *Aeromonas hydrophila*	Indian major carps	Dropsy
Streptococcus agalactiae (group B) vaccine	Tilapia	Streptococcosis
Betanodavirus	Grouper	Betanodavirus disease

METHODS OF VACCINE ADMINISTRATION

Vaccines are administered to fish in one among 3 ways: by immersion, by mouth, or by injection. Every methods has its benefits and drawbacks. The foremost effective method can depend on the pathogen and its natural route of infection, the life stage of the fish, production techniques, and alternative supply concerns. A specific route of administration or even multiple applications using totally different strategies is also necessary for adequate protection.

1) Immersion method

The biomass of the fish to be vaccinated is calculated since the vaccine is administered on a combined body-weight basis. Additionally the minimum size of the fish is checked since there will be a minimum size below that fish shouldn't be vaccinated – the vaccine data sheet and package insert will provide info on the minimum size of fish for vaccination with the actual vaccine. The vaccine is diluted according to specific

directions using some of the water during which the fish are kept, and the fish are immersed in batches within the diluted vaccine for the recommended time usually around thirty seconds. Every bottle of targeted vaccine are adequate to vaccinate a designated weight of fish. Throughout immersion care should be taken to aerate the diluted vaccine while the fish are in it. Also follow the vaccine instructions in respect of minimum temperatures below that fish shouldn't be vaccinated. this is often as a result of the fish immune reaction can depend upon the temperature of the water in which the fish are kept, and below temperatures like 4 - 5ºC the response will be insufficient to confirm adequate protection. All fish vaccines can carry the recommendation that only healthy fish should be vaccinated. Also individual vaccines shouldn't be mixed.

2) Oral method

The method of oral administration can vary according to the vaccine. The three methods are top-dressing the finished feed with the vaccine powder using an adhesive agent such as edible oil or may be gelatin, spray-dressing the finished feed if the vaccine is in liquid form, or incorporating the vaccine into the feed throughout the feed production process. The biomass of the fish to be vaccinated should be estimated and the vaccine mixed with the feed according to the manufacturer's instructions. With liquid vaccines, bring the vaccine to room temperature (20^{o}C) for 1 hour before use to allow the vaccine to become more liquid. If any separation occurs, shake the bottle vigorously until the separated layers are completely distributed. Turn the required weight of feed pellets in a mixer, e.g. a concrete mixer, and slowly pour or spray the vaccine directly onto the pellets. If a sprayer is used, it should be set to deliver a coarse spray without risk of aerosol particle generation and the spray container must be completely emptied during the mixing operation. Mix the pellets for at least 2 minutes after all the vaccine has been added. Keep the prepared feed for 1 hour before feeding, to permit the vaccine to impregnate the pellets completely.

The vaccine-incorporated feed should then be fed according to the vaccine manufacturer's instructions, as a course of vaccine may be required to induce an adequate immune response. The vaccine manufacturer's guidance on storage of feed containing vaccine should be observed, as well as the minimum size of fish which can be vaccinated with any particular vaccine.

3) Injection method

The vaccine-incorporated feed should then be fed according to the vaccine manufacturer's instructions, as a course of vaccine may be required to induce an adequate immune response. The vaccine manufacturer's guidance on storage of feed containing vaccine should be observed, as well as the minimum size of fish which can be vaccinated with any particular vaccine.

RECENT DEVELOPMENT IN FISH VACCINOLOGY

During the last twenty years vaccination has become established as a very important technique for prevention of infectious diseases in farmed fish, mainly salmonid species. So far, most commercial vaccines are inactivated vaccines administered by injection or immersion. Microorganism infections caused by gram-negative microorganism like *vibrio sp., Aeromonas sp., and Yersinia sp.* are effectively controlled by vaccination. With *furunculosis*, the success is attributed to the utilization of injectable vaccines containing adjuvants. Vaccines against virus infections, as well as infectious pancreatic necrosis, have also been utilized in commercial fish farming. Vaccines against many alternative microorganism and viral infections are studied and located to be technically possible. The positive effect of vaccination in farmed fish is reduced mortality. However, for the longer term of the fish farming industry it\'s additionally necessary that vaccination contributes to a sustainable biological production with negligible consumption of antibiotics.

THE GENERAL KEY RULES OF FISH VACCINATION

- Do not let vaccines solve your farming problems. Events or practices like overstocking, undue stress, or poor water quality will cause breakdowns in vaccine protection.
- Only vaccinate healthy fish. The performance of vaccines is incredibly dependent on the health status of the fish at the time of vaccination. Vaccines can not be expected to provide sensible or long term protection if the fish are sick, in poor condition, or they are carriers of pathogens once vaccinated.
- Allow adequate time for immunity to develop. Immunity takes time to develop and therefore vaccinated fish are not directly protected. Thus, vaccinated fish should be maintained throughout this point within the less stressful conditions as possible. The time of the event of

immunity depends mainly upon the surrounding water temperature (i.e. at 10ºC it takes 15-20 days).

- Strictly follow the recommendations of vaccine usage once immunizing fish. don\'t attempt to shorten the recommended time of exposure to the vaccines; don't modify the dilution or dose recommended; don't overload the net once fish are vaccinated by dip immersion; do make sure that the water used to dilute the vaccine could be a similar temperature to it during which the fish are being held; don't use the vaccine when the expiry knowledge.
- Do not expect vaccines to eradicate disease. If vaccines against a specific disease are used routinely on the farm, proof of this disease can mostly disappear. However, this doesn't mean that the organism that causes the disease has been eradicated. In fact, it's still present and capable of infecting vulnerable unvaccinated fish.

FUTURE PROSPECTS

- To achieve progress in fish vaccinology, a rise within the co-operation between basic and technology (i.e., between the immunologist/microbiologist and also the vaccinologist) is required.
- Since there is not continuously correlation between the main antigens expressed in vitro and those expressed in vivo, the event of simpler vaccines for the diseases in aquaculture should rely in the identification of the vital immunogens expressed by the pathogens in vivo, and also the choice of in vitro conditions that maximize their expression.
- Improvement in oral immunization with perishable micro particle-based vaccines to be used for booster vaccination.
- Development of recent non-mineral oil adjuvants lacking aspect effects.
- Development of polyvalent vaccines and standardization of a vaccination calendar applicable for every economically necessary fish species.
- Investigation of the mechanisms of immunoglobulin transfer from pre-spawning females to offspring as a helpful method of protective fish against pathogens that have an effect on early life stages.

CONCLUSION

In addition to optimizing farming and general management practices, use of vaccines continues to be limited, is turning

into additional widespread in certain sectors of aquaculture for disease prevention. Varieties of vaccines are in use by the salmonid industry for many years. However, commercial vaccine development for aquaculture cultivation sectors, as well as producers of warm water fish, remains quite restricted. Larger demand by producers and increased levels of research and interest by manufacturers is helping to form vaccination an additional viable choice. Currently, vaccines are available for a few economically necessary microorganism and viral diseases. Vaccines for defense against parasitic and fungal diseases have not yet been developed. Vaccination should be considered a part of a comprehensive fish health management scheme, and not the only solution for a disease problem.

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Dairy sector in India: Present Scenario

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"The Indian dairy sector has acquired substantial growth momentum from 9th Plan onwards as a result of which the country now ranks first among the world's milk producing nations, achieving an annual output of about 130 million tonnes. This represents sustained growth in the availability of milk and milk products for our growing population. Dairying has become an important secondary source of income for millions of rural families and has assumed the most important role in providing employment and income generating opportunities particularly for marginal and women farmers. The growth of the sector implies far reaching results in rural India in poverty alleviation and in improving the health status of rural people. This chapter highlights the dairy scenario of India, in general"

Dairy activities have traditionally been integral to India's rural economy. The country is the world's largest producer of dairy products and also their largest consumer. Almost its entire produce is consumed in the domestic market and the country is neither an importer nor an exporter, except in a marginal sense. In the last three decades, world milk production has increased by more than 50 percent, from 470 million tonnes in 1981 to 727 million tonnes in 2011. Since the 1970s, most of the expansion in milk production has been in South Asia, which is the main driver of milk production growth in the developing world. India is the world's largest milk producer, with 16 percent of global production, followed by the United States of America, China, Pakistan and Brazil. The countries with the highest milk surpluses are New Zealand, the United States of America, Germany, France, Australia and Ireland. The countries with the highest milk deficits are China, Italy, the Russian Federation, Mexico, Algeria and Indonesia. Cows produce 83 percent of world milk production, followed by buffaloes with 13 percent, goats with 2 percent and sheep with 1 percent; camels provide 0.3 percent. The remaining share is produced by other dairy species such as equines and yaks. About one-third of milk production in developing countries comes from buffaloes, goats, camels and sheep. In developed countries, almost all milk is produced by cattle. Cattle produce about three-quarters of milk production in sub-Saharan Africa, about half in Asia – with most of the other half coming from buffaloes and nearly all the milk produced

in Latin America. Globally, the consumption of protein is increasing faster than population growth. Global consumption of protein increased from 3.7 to 5.4 lakh tonnes per day - CAGR of 2%. While Global population increased from 5.4 to 7.0 billion - CAGR of 1%. The Increasing proportions of this growth is from animal protein

- ✓ Meat - 2.9 %
- ✓ Dairy – 0.5 % increase
- ✓ Vegetables, soya and fruit – 2% increase
- ✓ Cereals - decreased 6.2%

The Demand for animal proteins likely to continue to increase faster than other categories.

Three regions are the key contributors to this rising consumption:

Change in proportion of protein consumption:

Asia - increased by 4.8 percent

Africa - increased by 2.3 percent

South America - increased by 0.6 percent

North America - dropped by 0.8 percent

Europe - dropped by 6.7 percent

These regions have driven growth in dairy consumption as well however, per capita consumption remains much lower than developed countries. Global per capita consumption estimated to be 103 Kg/year in 2011 Estimated to have grown at about 17% over the last decade.

Indian perspective

India has one of the largest livestock populations in the world. Fifty per cent of the buffaloes and twenty per cent of the cattle in the world are found in India, most of which are milk cows and buffaloes. Dairy development in India has been acknowledged the world over as one of modern India's most successful developmental programmed. .Growing at about 10 per cent annually, the Indian dairy industry is predominantly controlled by the unorganized sector which accounts for nearly 85 per cent. About 60 per cent of milk produced is consumed in the liquid form due to conventional dietary habits of Indian households and rest is consumed in the form of butter, clarified butter, cheese, curd, cottage cheese, ice cream, dairy whiteners and traditional sweets.

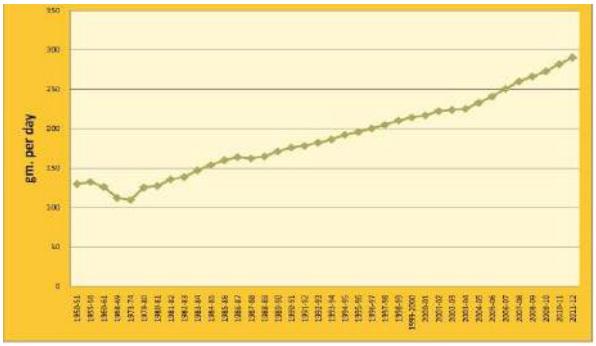

Figure 1: *Per capita availability of Milk (grams/day)*

India's dairy sector growth in the past two decades has been mainly due to the private sector. Andhra Pradesh, Bihar,

Haryana, Gujarat, Madhya Pradesh, Maharashtra, Rajasthan and Uttar Pradesh are leading milk producing States in India. Twenty-first-century India has emerged as the milk bowl of the world. India became the largest producer of milk in the world, outstripping the US, almost 15 years ago, and today accounts for 17 per cent of global milk production. According to the Economic Survey 2012-13, milk production has gone up from 53.9 million tonnes (MT) in 1990-91 to 127.9 MT in 2011-12. In 2012-13, the country produced more than 132.4 MT of milk. India is also the largest consumer of milk in the world. Commensurate with its production capacity, the per capita availability of milk increased from 176 grams per day in 1990- 91 to 290 grams per day in 2011-12. The world per capita availability of milk in 2011 was 289.31 grams per day. The milk economy of the country has been growing at a sustained pace and it would not be premature to say that India would achieve its estimated requirement of 150 MT of milk by the end of the 12th Five Year Plan period (2012-17).

Role of Dairy sector in national economy

India's dairy sector growth in the past two decades has been mainly due to the private sector. Andhra Pradesh, Bihar,

Haryana, Gujarat, Madhya Pradesh, Maharashtra, Rajasthan and Uttar Pradesh are leading milk producing States in India.

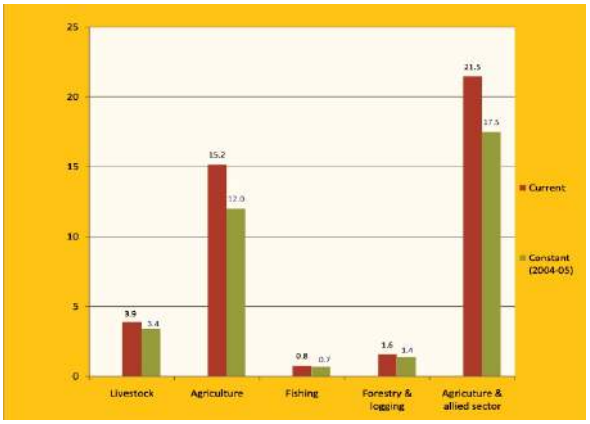

Figure 2: *Share of livestock and fisheries sectors and total in the GDP of India*

India's dairy sector growth in the past two decades has been mainly due to the private sector. Andhra Pradesh, Bihar, Haryana, Gujarat, Madhya Pradesh, Maharashtra, Rajasthan and Uttar Pradesh are leading milk producing States in India.

It also has the world's largest dairy herd (comprised of cows and buffalos). In 2010-11, livestock generated output worth INR 2,075 billion (at 2004-05 prices) which comprised 4 percent of the GDP and 26 percent of the agricultural GDP. The dairy industry is expected to grow 4-5 percent per annum. A budgetary outlay of Rs. 31, 560 Crores is recommended by the working group for 12th Five Year Plan of Planning commission of India for animal husbandry and dairy sector to achieve

growth rate of 6 percent. In the past 20 years, milk production in India has doubled and has reached the 116.2 million tonnes a year thus becoming India's No.1 farm commodity. The Indian dairy industry reported a market size of USD 48.5 billion in FY2011. With a Compound Annual Growth Rate (CAGR) of 16 percent, it is anticipated to reach USD 118 billion in 2017. On the back of a rise in disposable income, coupled with strong demand for dairy products, the Indian dairy industry is all set to experience high growth rates in the next five years. Exports of dairy products stood at INR 2,618.72 crore (US$ 429.6 million) during April-December 2013, up 162 per cent over INR 996.86 crore (US$ 163.5 million) a year ago. Experts are pegging the value of Indian dairy exports at a bullish INR 5,000 crore (US$ 820.4 million) for the current financial year.

Bovine genetic resources

Indigenous animals are sturdy, are endowed with quality of heat tolerance, resistance to diseases and ability to thrive on low quality nutrition. There are well 37 recognized breeds of cattle Among important breeds of Indian cattle breeds, Gir, Sahiwal, Red Sindhi and Tharparkar breeds were for milk, with an average milk production of 1500 kg/lactation and 6-8 dual purpose breeds with an average milk yield of 1000-1500 kg/ lactation (Haryana, Kankrej, Rathi, Ongole, Dangi, etc.) and the rest of the 12-15 breeds were draft breeds with an average milk yield below 500 kg/lactation(Kangayam, Umblacherry, Amritmahal, Hallikar). There are 13 well recognized breeds of buffaloes in India The river buffalo, extensively used in the Indian subcontinent for milk production, has a production average between 1181 kg to 1934 kg with lactation lengths ranging between 283 and 313 days. The most widespread breed is of the Murrah type which has also been exported to several southeast and east Asian countries for crossbreeding with swamp buffalo. Murrah breed accounts for 205 of the country's total buffaloes. The latter breed, rarely used for milk production, produces less than 800 kg per lactation of about 250 to 330 days.

Milk production

India ranks first among the world's milk

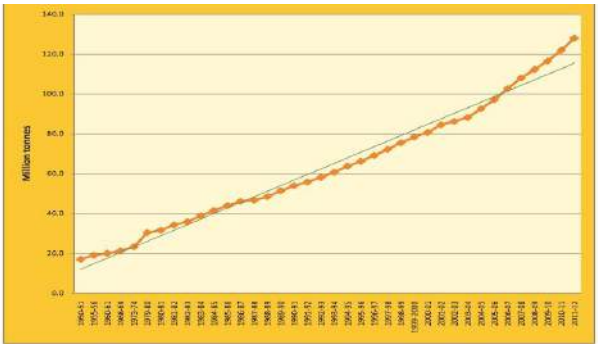

Figure 3: *Milk production of India*

producing countries, followed by USA and china. India is the leading milk producer

since 1998. During 2011-12, India produced a total milk of 127.9 million tonnes. The milk production in India during the period from 1999-2000 to 2010-2011, increased from 78.3 million tonnes to 121.85 million tonnes, an increase of 55.6 percent During the same period (2000-2010) world milk production increased from 57.8 million tonnes to 717.37 million tonnes, an increase of 24.6 percent. An increase in the growth rate of milk production has contributed to an increase in per capita availability of milk. Thought the human population has also increased. The domestic per capita availability of milk is about 281 grams per day in 2010-2011 as against the world average of 284 grams per day.

Demand of milk

Presently, about 48 percent of the milk production is consumed locally in the villages and the balance is sold. About 30 percent of the milk sold is handled by organized sector and the remaining 70 percent by unorganized sector. Out of share of 30 percent handled by the unorganized sector about 165 is handled by cooperative sector. In 1950-51, the country's milk production was 17.0 million tonnes which has now increased by 7 folds and present productivity has reached 121.85 million tonnes in 2010-2011. The milk production for year 2012-13 was 132.4 MT .Dairy cows contribute 40% of total milk produced in the country and the rest 60% by buffaloes (55% and other species (5 percent). It is estimated that demand for milk is likely to be 155 million tonees in 2016-17. And around 200 million tonnes by by2020-21. To meet the growing demand for milki production it is imperative to increase the annual incremental milk production from 4 million tonnes in past 10 years to 7.5 million tonnes in next 10 years.

Major challenges

The livestock sector in India faces the following major challenges which need to be addressed enabling the sector to grow according to its potential. Production is high but individual animal productivity is low. Since 1998 India is rated as the highest milk producer in world with 199 million cattle and 105 million buffaloes we produce around 17 percent of world's total milk production. Ever rising demand for milk and dairy products across globe offers exciting market opportunities for India. The major concern here is that the individual animal milk productivity remains one of the lowest among all leading milk producing countries of the world. The milk production /cow/year in developed countries like USA, Denmark Sweden etc are above 7500 kg whereas in

India the average milk production /cow/year is only 1169 kg indicating there is enough scope to improve the productivity.

Dilution of indigenous germplasm

For the genetic improvement of dairy animals exotic germ plasm was imported and crossbreeding was practised which led to increased crossbred cow population. The crossbreeding increased the milk production but also led to dilution of Indian local breeds. For instance the population of crossbred cows increase at the rate of 7.5 percent during 1982-92 compared to 0.1 percent for indigenous cows. The annual growth rate of crossbred cattle during 2003-07 was 7.58 percent while the corresponding growth rate of indigenous cattle was 0.85 percent if the same trend continues we may lose our valuable indigenous cattle breeds. Among the indigenous breeds (Punagaur, Kasagode dwarf and Kumauni) are reported to be endangered, two breeds (Krishna valley and tarai) are vulnerable and one breed (Vechur) is reported to be critical. In buffaloes two breeds (Chilka and Manda) are endangered and Kujang breed is classified as vulnerable.

High population of low producing animals

A total of 16.6 percent of the cattle population belongs to exotic/crossbred, 11.6 percent to well described indigenous breeds. A large proportion (138.7 million-69.7 percent of the total cattle population has been classified as non-descript. There is a possibility of many homogenous populations deserving the status of breeds in this huge non-descript category. Once the animals deserving breed status are recognized properly, we need to evolve suitable policies to improve their productivity. Efforts should be made to restrict the growth of low producing animals as they compete with high yielders for common resources.

Inadequate breeding facilities

Although, India has one of the largest breeding infrastructure in the world (49 frozen semen station,3321 bulls and 84000 artificial insemination centres) with total production of about 61 million frozen semen straws every year and 61 million artificial inseminations(AI) we could hardly cover 25 percent of the breed able population. To achieve the national target of 50 percent AI coverage by 2021-22 we require high number of superior bulls and the semen production must reach 140 million doses from the present 51 million doses. Thus the major limiting factor has been the availability of superior bulls and the situation is further

aggravated by poor quality semen produced by breeding bulls

Poor outreach of veterinary health services

The current efforts of prevention and control of livestock diseases needs to be strengthened. There is a shortage of veterinary and para-veterinary manpower and facilities including mechanisms for diagnosis, treatment, tracking and prevention of the diseases. Adequate infrastructure for ensuring bio-security, proper quarantine systems and services to prevent the ingress of diseases across the states and national borders is not available

Shortage of quality feed and fodder

While the livestock population is increasing, the gap between the requirement and availability of feed and fodder is increasing primarily due to decreasing area under fodder cultivation and reduced availability of crop residues as fodder. There is continuous shrinkage of common property resources leading to over grazing in the existing grasslands. It is imperative to arrange sufficient good quality feed and fodder for efficient utilization of genetic potential of the various livestock species and for sustainable improvement in productivity The area under fodder crops in India has stagnated at about 8.5-9 million hectares during past decade and accounts for only about 4.6 percent of total cultivated area.

Inadequate Infrastructure for Marketing, Processing and Value Addition

The livestock sector is handicapped due to inadequate marketing and processing infrastructure as a result of which the primary producers do not get remunerative prices most of the times. Although various initiatives for dairy development have resulted in vibrant dairy cooperatives in many states, but still large number of dairy farmers are not covered by cooperatives. The dairy cooperatives handle only about 8 percent of milk production. Still major share of marketable surplus of milk and other livestock products are not handled by organized processing industry, resulting in reduced price realization by farmers and post production losses and wastages.

CONCLUSIONS

Despite being the world's largest producer, the dairy sector is by and large in the primitive stage of development and modernization. Though India may boast of a 200 million cattle population, the average output of an Indian cow is only one seventh of its American counterpart. Indian breeds of cows are considered inferior in terms of productivity. Moreover, the sector is plagued with various other impediments like shortage

of fodder, its poor quality, dismal transportation facilities and a poorly developed cold chain infrastructure. As a result, the supply side lacks in elasticity that is expected of it. On the demand side, the situation is buoyant. With the sustained growth of the Indian economy and a consequent rise in the purchasing power during the last two decades, more and more people today are able to afford milk and various other dairy products. This trend is expected to continue with the sector experiencing a robust growth in demand in the short and medium run. If the impediments in the way of growth and development are left unaddressed, India is likely to face a serious supply - demand mismatch and it may gradually turn into a substantial importer of milk and milk products. Fortunately, the government and other stakeholders seem to be alive to the situation and efforts to increase milk production have been intensified. Transformations in the sector are being induced by factors like newfound interest on the part of the organized sector, new markets, easy credit facilities, dairy friendly policies by the government, etc. Dairy farming is now evolving from just an agrarian way of life to a professionally managed industry the Indian dairy industry. With these positive signals, there is hope that the sector may eventually march towards another white revolution.