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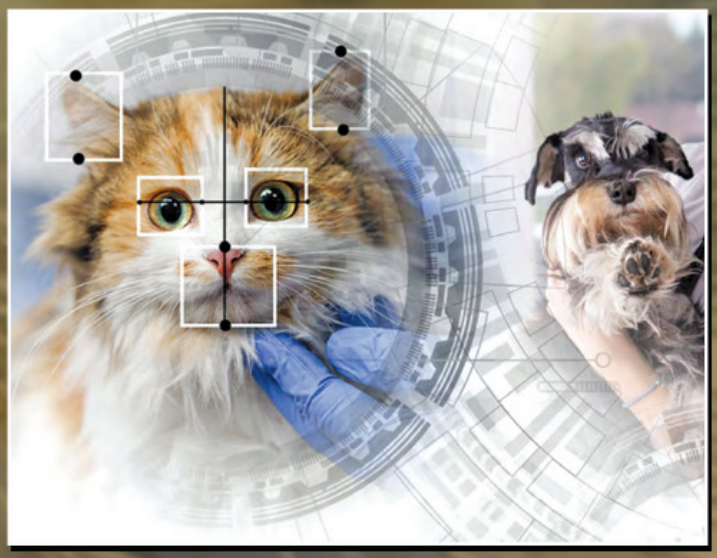

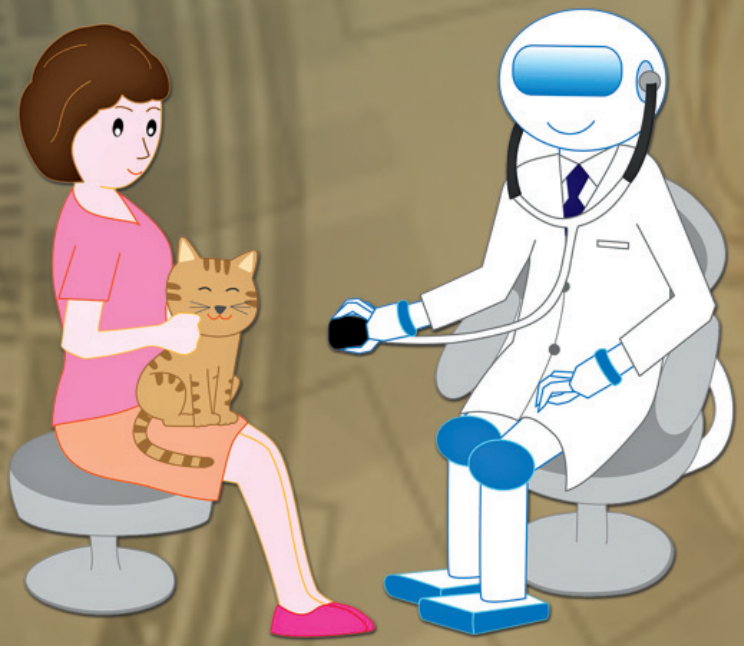

Applications of Artificial Intelligence in Animal...

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LIVESTOCK AND POULTRY SECTOR IN ASSAM : CHALLENGES AHEAD

Livestock and poultry sector is a major contributor to our Agricultural GDP .Even then it has been facing a lot of challenges in different angle of practices. In our state increasing trend of feed price rise has become a major issue to the livestock and poultry entrepreneurs. As a result, cost of production is in higher trend than the cost of realization. It is known fact that 90% of feed is usually supplied from the states like Bihar, UP, West Bengal etc. wherein quality of feed as per BIS standard is a big question. Hence, establishment of feed mill in private or cooperative sector is the need of the hour .The subsidized electricity and transportation cost to the feed mill at par North East Industrial Policy, may minimize the feed cost at farmer's door step. On the other hand ,the proposed project for production of 10 lakhs litre milk per day in our state under NDDB may support the interested Industrialist or entrepreneurs for setting up of feed mill in our state or may 50% subsidy in capital expenditure of feed mill under investment policy of livestock and poultry sector if adopted by the state Government.

An ensured market and right price will definitely lead the growth of this sector besides attracting unemployed youths to this sector .Therefore, livestock and poultry activities shall not be treated as agricultural activities but to take it as industry from production at farmer's point to value addition of the product. To carry out these efforts, a concrete Investment Policy for Livestock and Poultry Sector is a must. The Government can not absorb the unemployed alone, but livestock and poultry sector can do a lot for them as well as enhance the growth of economy through livestock.

Banking sector can play a major role for boosting rural economy if they show interest for sanctioning of loan to poultry and livestock farmers as per credit plan of NABARD. But it is unfortunate that bankers are very much reluctant to grant sanction to it and as a result huge amount of subsidy has to be sent back to central government. In this regard, selection of right farmer for loan shall be undertaken with due consultation with local Veterinary Officer.

Some emerging diseases like African Swine Fever, Lumpy Skin Disease has become a major threat to cattle and piggery farming and has caused economic loss to the entrepreneurs and yet to recover from it. An inertia has been noticed in piggery farming and pork market while pig supply to our state on regular basis from Haryana, UP, Punjab has become a concern to our farmers. To revive the piggery farming , a massive awareness on bio-security, its application and publicity among the farmers community shall be the priority and need of the hour.

APPLICATIONS OF ARTIFICIAL INTELLIGENCE IN ANIMAL HEALTHCARE

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The simulation of human intelligence in machines is referred to as artificial intelligence (AI) and has evolved into several subfields like machine learning, deep learning etc. Machine learning (ML) mainly includes the development of algorithms for identification of specific patterns present in data and made predictions using a model trained on given data. Digitized healthcare presents numerous opportunities for reducing human errors, improving clinical outcomes, tracking data over time, etc. Recently, AI has emerged as a tool that empowers farmers in monitoring, forecasting, optimizing the farm animal growth, tackling parasites, biosecurity, diseases, monitoring of farm animal along with farm management are some of the thrust areas in livestock industry where the use of AI technology can play rich dividends. It encompasses a large range of theories and technologies used to solve problems of high logical or algorithmic complexity. It crosses many disciplines, including mechanistic modeling, software engineering, data science and statistics. Introduced in the 1950s, many AI methods have been developed or extended recently with the improvement of computer performance. The term Artificial Intelligence (AI) was stamped by John McCarthy (Crevier, 1993). The founders of AI were Allen Newell (CMU), Herbert Simon (CMU), John McCarthy (MIT), Marvin Minsky (MIT) and Arthur Samuel (IBM).

Artificial Intelligence (AI) has ability to addresses the following issues regarding animal healthcare:

(i) Understanding a situation and its dynamics. e.g., epidemic spread.
(ii) The perception of the environment, which corresponds in animal husbandry to the detection of patterns (e.g., repeated sequence of observations), forms (e.g. of a protein) and signals (e.g. increased mortality compared to a baseline) at different scales.
(iii) Computer based decision making, or, more realistically, human decision support (e.g. expert systems, diagnostic support, resource allocation).

Artificial Intelligence (AI) can be used for:

(i) To disease case detection and its diagnosis.
(ii) Reliable predictions without the assistance of experts with higher accuracy.
(iii) To representing more realistically complex biological systems.
(iv) To speed-up decision-making process and improving accuracy in risk analyses.
(v) To better targeted interventions and anticipated negative effects of interventions, if any.

Artificial Intelligence (AI) and its subfield:

(i) Machine learning (ML): Machine learning (ML) is the process of utilizing mathematical models of data to make computer learn without direct instruction given. With the appli-

cation of algorithms, it helps in identification of latent patterns within the data and thus creates a model to make predictions and decisions. With experience and provision of large number of data, accuracy in machine learning achieved. It requires human engineering and domain expertise to design information extractor that can transform raw data into suitable representation from which algorithm model can learn and detect patterns (El-Naqa *et al.*, 2015).Machine learning also plays a role in phenotype prediction from genetic data, disease risk, forecast of epidemic and pandemic (Esteva *et al.*, 2019).

(ii) **Deep learning:** Deep Learning is a subset of Machine Learning that is inspired by the structure of the human brain. Deep learning algorithms continually examine data using a predetermined logical structure in an effort to reach conclusions that are comparable to those reached by humans. Artificial neural networks have unique capabilities that enable deep learning models to solve tasks that machine learning models can never solve. This is possible with deep learning because in this technique features are extracted automatically using the feature extractor generally called filters. Deep leaning can be applied to the data, images, or sound.

Application of AI in animal healthcare:

● **Disease outbreak prediction:** The National Animal Disease Referral Expert System (NADRES) of ICAR-NIVEDI is a system that works on combining and coordinating the alert and response mechanisms for the stake holders in prediction, prevention and control of animal disease threats (zoonotic ones also) through sharing of data, epidemiological studies and filed missions to asses and prevent outbreak, whenever needed. Combining livestock disease data and Artificial Intelligence techniques provide new opportunities to prevent outbreak and maintenance in the animal healthcare sector (Suresh *et al*., 2019).

● **Diagnosis of canine disease:** Application of artificial intelligence for detecting left atrial enlargement on canine thoracic radiology (Li *et al*., 2020). Machine learning algorithm for diagnosis of chronic hypoadrenocortism in dogs (Raegen*et al*., 2019). Deep convolutional neural network in discriminating between meningiomas and gliomas in canines MRI images, with accuracy of 94% (Banzato*et al*., 2018). Makielski*et al*. (2021) by using a novel xenograft platform and machine learning, developed an exosomal gene signature to detect residual disease in dogs with osteosarcoma.

●**Image based diagnosis of zoonotic protozoan parasites:** Microscopy is one of the most commonly used methods for the diagnosing of the parasitic diseases. However, microscopy-based parasite identification and quantification is challenging, time consuming and labor intensive, requires microscope and well-trained researchers. Parasite examination in microscopic images is challenging because of the variations and uncertainties in the shape, density and staining color of the parasites as well as low parasite levels. Deep learning has been widely applied in various microscopic image (malaria parasite) analyses due to its high speed, accuracy, flexibility and low cost (Li *et al*., 2021). Notably, smartphones play an important role in developing parasite diagnosis algorithms, thus greatly reducing the need for well-trained microscope operators (Abdurahman *et al*., 2021).

Pros and cons of AI:

Major limitations of application of AI in diagnosis and treatment are:

1. Lack of reliable data capturing system.
2. Requiredlarge volume of image/ text samples which are not readily available.
3. Samples are structured with scattered.
4. Non-uniform information that did not help in facilitation in the learning process of deep learning models.
5. Most of the models require labelled data for supervised learning.
6. Manual labeling of data is a challeng-

ing task (Anwar et al., 2018) for which skilled labour is required (Esteva et a*l.*, 2019).

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PATHOLOGY OF LABORATORY ANIMAL DISEASES : A RETROSPECTIVE STUDY

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ABSTRACT

A total of 310 carcasses of laboratory animals that included, mice (112), rat (96), rabbit (62) and guinea pig (40) were subjected to post-mortem examination at the Department of Pathology, College of Veterinary Science Khanapara. A detailed post mortem examination was conducted in all the carcasses. Out of 310 carcasses the percentage of mortality recorded in mice (36.12%), rat (30.96%), rabbit (20%),and guinea pig (12.90%). In the entire laboratory animals the common causes of mortality were pneumonia (25.66%), gastroenteritis (21%), septicemia (17%), protozoan infection (12.6%), parasitic infection (16.33%) and skin infection (32%). Most significant findings of the present investigation was hepatic coccidiosis caused by Eimeria stiadae in rabbit and Cysticercus fasciolaris in mice. In all the cases diagnosis of the diseases were based on history, bacteriology, parasitology and histopathology for confirmatory diagnosis.

INTRODUCTION

Laboratory animals have contributed greatly to our knowledge of biological structure and function (Clark *et al*., 1997) and are essential tools in biomedical research and training (Tsegaye and Shiferaw, 1999). They are used extensively in the safety evaluation of different therapeutic drugs, foods, chemicals and in a broad variety of biological investigations (Clark *et al*., 1997), for the diagnosis of infectious diseases, in the production of vaccines, sera and other biological substances of public health and veterinary importance. It is well established that, the use of disease free animals can often lead to a substantial reduction in the number needed for any given experiment (John and Michael, 1976 ;Tsegaye and Shiferaw, 1999). In India the majority of laboratory animal units have a simple barrier system and usually have no specific disease free status. Under such conditions Laboratory animals can get infected by many diseases and results in consequent loss of time, money and research effort.

There is only little information available regarding laboratory animal situations in India. Systemic assessment of the problems and evaluating its magnitude are essential steps to improve the situation. Therefore, the study was carried out to identify and determine the prevalence and associated risk factors of diseases in laboratory animals.

MATERIALS AND METHODS

Laboratory animals subjected for post mortem examination in the Department of Pathology,C.V.Sc, Khanapara,AAU. Various species of laboratory animals were received from different sources. Commonly mouse *(Mus musculus),* rat*(Rattus norvegicus),* guinea-pig *(Cavia porcellus),*and rabbit *(Oryctolagus cuniculus)*were exmined. Post-mortem examination and laboratory tests were performed as per standard methods.

RESULTS AND DISCUSSION

A retrospective study was carried out from 2010- 2020 on laboratory animal disease based

on post mortem examinations conducted in the Department of Veterinary Pathology, Khanapara.The detail post-mortem findings and their diagnosis of diseases with mortality percentage were presented in the table 1.

Out of the 310 carcasses examined, pneumonia (24.83%), gastritis (20.32%), septicaemia (16.45%), parasitic infection (15.80%), protozoa infection (12.25%) and skin infection (10.32%) were recorded. Highest incidence of death recorded in mice (36.12%) followed by rat (30.96%), rabbit (20%) and guinea pig (12.90%). Among all the diseases incidence of pneumonia was highest (24.83%) followed by gastroenteritis, septicaemia, parasitic infection, protozoal infection and skin disorders. Various gastrointestinal diseases were recorded in mice, rats, rabbits and guineapig. Most significant findings were haemorrhagic gastroenteritis, caecal coccidiosis and hepatic coccidiosis (rabbit). On post-mortem examination, some rats(Fig. 1) showed presence of few marble sized cyst(Fig.2) with elongated, pale white translucent, segmented cestode larvae.The larvae were morphologically similar with the cat tape worm *Taenia taeniformis (Strobiloc*erci) Microscopically, the segments of larvae with large scolex and posterior bell shaped proglotids were observed (Fig. 3).

In the present study, hepatic coccidiosis in rabbits were observed. Grossly the liver revealed multifocal, well demarcated yellow or pearl grey nodules in the liver. Microscopic lesion showed severe biliary hyperplasia with numerous coccidian ocyst. There was proliferation of bile duct epithelium which appeared finger like projections (Fig.4). This findings were in agreement with the previous workers (Sastry and Rao, 2008)and also reported that E. steidae causes papilliferous cystadenoma af bile duct epithelium in rabbits as a result of mechanical and toxic irritation. Present investigation has concurrence with the findings of Cooper (1976),Seamer (1967).

Table: 1. Diseases of laboratory animals with the rate of mortality

Animal	Pneumo Nia(%)	Gastro-Enteritis (%)	Septicae mia (%)	Parasitic infection (%)	Protozoa Infection (coccidiosis) (%)	Skin disorder (%)	Total(%)
Mice	28(25)	24(21.4)	18(16)	12(10.7)	15(13.39)	15(13.39)	112(36.12)
Rat	21(21.87)	18(18.75)	16(16.66)	19(19.74)	13(13.54)	9(9.37)	96(30.96)
Rabbit	17(27.41)	12(19.35)	10(16.12)	11(17.74)	7(11.2)	5(8.06)	62(20)
GuneaPig	11(27.5)	9(22.5)	7(17.5)	7(17.5)	3(7.5)	3(7.5)	40(12.90)
Total	77(24.83)	63(20.32)	51(16.45)	49(15.80)	38(12.25)	32(10.32)	

Laboratory animals reared under captive condition used to suffered from bacterial and parasitic infections. Strict hyegiene, sanitation and proper health management should be undertaken to protect the laboratory animals from various infectious diseases and maintained the in a disease free environment.

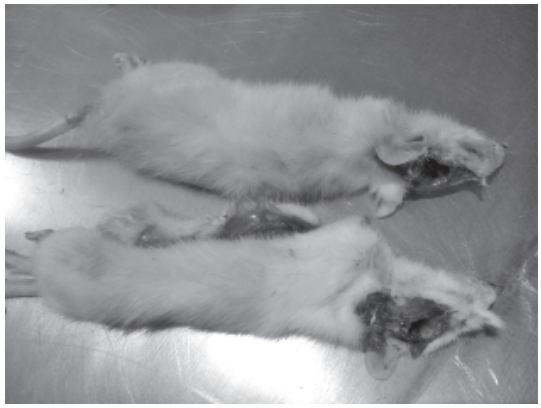

Fig. 1: *Rats at PM.*

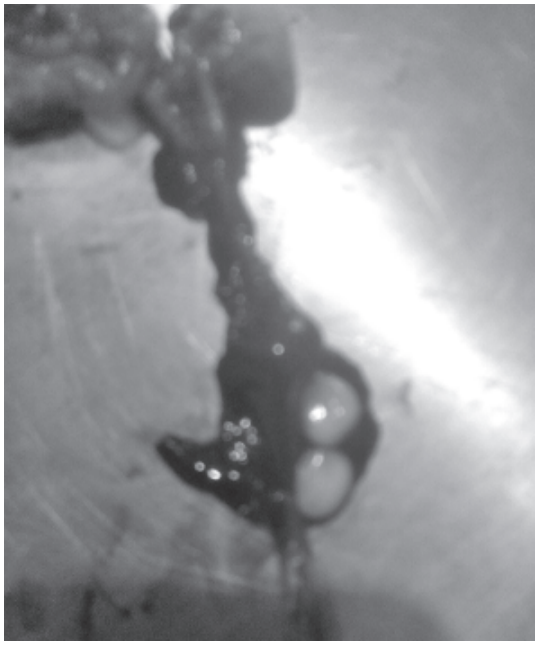

Fig. 2: *presence of marble sized cysts of Taenia taeniformis in the liver of rat*

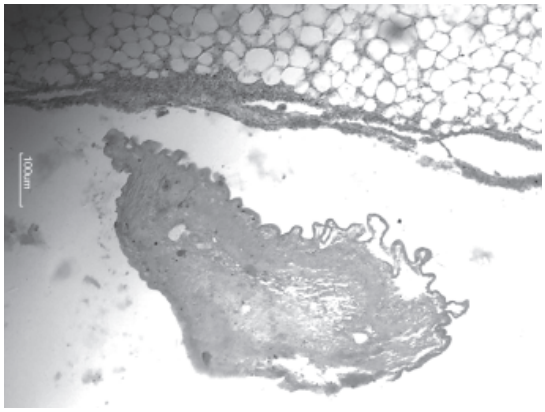

Fig.3: *The segments of Taenia taeniformis larvae within the cyst in the liver. HE X 100*

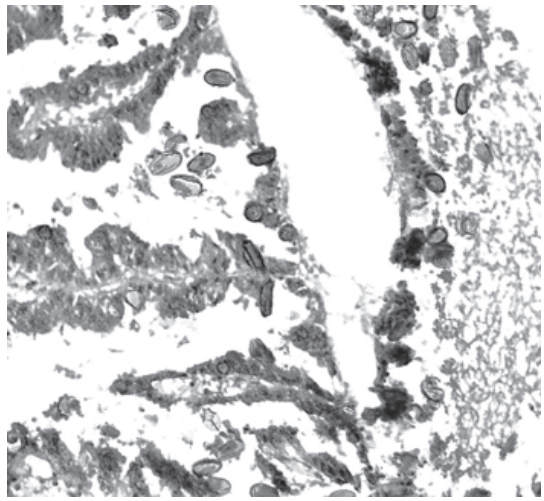

Fig.4: *Proliferated bile duct epithelium showed finger like projections with numerous coccidia ocysts HEX100*

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ANTIFUNGAL RESISTANCE: CURRENT TRENDS AND FUTURE STRATEGIES

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ABSTRACT

Due to the small number of systemically accessible antifungal medications, antifungal resistance poses a significant therapeutic issue for clinicians treating invasive fungal diseases. Additionally, drug-drug interactions and major side effects/toxicities may be a limitation of existing medications, preventing continued use or dosage escalation. Due to the rising occurrence of infections brought on by these species in various parts of the world and the higher prevalence of resistance to this widely used azole in many institutions, fluconazole resistance in non-Candida albicans species is of special concern. It has been shown that C. glabrata resistance to echinocandins is increasing at a number of US institutions, and a greater proportion of these isolates may also be azole resistant. Worldwide, it has also been discovered that Aspergillus fumigatus isolates that are azole resistant can result in invasive infections with significant fatality rates due to clinical and environmental exposure to this class of drugs. Additionally, a number of Aspergillus species and other mould species, such as those of the genus Scedosporium and the genus Fusarium, have decreased susceptibility to or pan-resistance to clinically accessible antifungals. Several prospective antifungals, some of which have the ability to overcome resistance seen against the azoles and the echinocandins, are now undergoing preclinical or clinical research. These include substances that also target the formation of ergosterol and b-glucan as well as drugs with unique modes of action that might also be able to get around the drawbacks of the currently known antifungal classes, such as resistance and negative side effects/toxicity. Very few drugs are used in veterinary practice. Hence much data is not available.

KEY WORDS

Antifungal drugs, Azoles, echinocandins, Aspergillus, Candida albicans, Resistance

INTRODUCTION

Clinicians responsible for treating patients at high risk for invasive mycoses are growing increasingly concerned about antifungal resistance. Following exposure to these medications, resistance to currently available antifungal medicines may emerge as a result of acquired mechanisms. Increased azole resistance among non-Candida albicans isolates, azoles resistance in Aspergillus fumigatus, and echinocandin resistance in C. glabrata are some recent developments in acquired antifungal resistance (1–3). Contrarily, some fungal species exhibit microbiologic resistance to all clinically available antifungals, while others are intrinsically resistant to specific medications (e.g., C. krusei and fluconazole or C. lusitaniae and amphotericin B) (e.g., Lomentospora [formerly Scedosporium] prolificans and Fusarium solani). 4–6 Additionally, new species are appearing that may exhibit resistance to certain classes of already used medicines (e.g., C. auris) [7].Treatment options for invasive fungal infections are limited, and patients at highest risk frequently have multiple comorbidities, including immun-

osuppression, which may limit the effectiveness of therapy even in the absence of drug resistance. This is true even though the prevalence of antifungal resistance is not at the levels observed for some bacteria against different antibiotics. In addition to overcoming the toxicities/ adverse effects and drug interactions linked to currently available antifungals, which itself potentially restrict the efficacy of therapy, it is evident that novel treatment approaches are required to address this issue. Antifungal resistance is a problem, however several novel antifungals are being tested in both preclinical and clinical settings. This review's goal is to describe the most recent developments in antifungal resistance and new antifungals that are being tested in patients with invasive fungal infections both in preclinical and clinical settings. Numerous extracts from various plants, including isolates resistant to currently available antifungal medications, have also been demonstrated to have activity against various fungi. A thorough examination of medicinal plants and their extracts, however, is outside the purview of this article. effects/toxicity.

Non *C. albicans* resistance

Azole reactivity Although *C. albicans* is the most prevalent Candida species cultured from patients with candidiasis, infections brought on by other species within this genus, such as C. glabrata, C. parapsilosis, and *C. tropicalis*, are becoming more significant in various parts of the world. The species can also vary between different geographic regions. This is significant since research from numerous institutions and geographical areas has indicated that resistance is rising in many non-C. albicans species. 8–10 According to the World Health Organization, fluconazole resistance is more prevalent in species other than *Candida albicans*(11). This is concerning because fluconazole is an easily administered, reasonably priced, and well-tolerated oral drug. Because point mutations in the ERG11 gene, which encodes the enzyme lanosterol 14a-demethylase, increase transcription of this gene, resulting in increased amounts of the enzyme, or efflux pumps, such as Cdr1 and Cdr2, which also affect this class of antifungals, reduce fluconazole susceptibility, it is possible that resistance to fluconazole also means resistance to other azoles (12,13).

As was previously mentioned, different geographic regions may have different predominate non-C. albicans species generating infections, and different institutions may have varying rates of azole resistance. Clinical practitioners' prescription habits for the prevention and treatment of invasive candidiasis may have an impact on this. 14 C. glabrata is the second most frequent cause of invasive candidiasis in the USA, and some institutions have been found to have fluconazole resistance rates as high as 12%–18%. 15,16 In contrast, C. tropicalis predominates in some Indian healthcare facilities, where fluconazole resistance rates might vary dramatically(17,18). In some Chinese hospitals, the prevalence of C. parapsilosis is comparable to that of C. albicans in terms of the quantity of isolates cultured from patients with invasive infections (19–22). Fluconazole susceptibility varies greatly amongst institutions as well, with some reporting no azole resistance and others reporting that the percentage of fluconazole-susceptible, dose-dependent plus resistant isolates in intensive care units may reach 50% (20,22).

Resistance to echinocandins

Due to the risk of resistance, echinocandins are recommended as the first line of therapy against invasive candidiasis in immunocompromised patients and those who have previously been exposed to azoles (23). Because their mechanism of action differs from that of azoles, echinocandins such as anidulafungin, caspofungin, and micafungin have been shown to maintain potent in vitro activity against many Candida isolates resistant to fluconazole and other triazoles(24). Resistance to echinocandins can develop in response to exposure to members of this

class, and this occurs through point mutations in highly conserved regions (i.e., hot spots 1 and 2) of the FKS1 and FKS2 genes, which encode subunits of the glucan synthase enzyme. 25 These hot spot regions are conserved across Candida species, and their detection in multiple species collected from patients who have experienced both microbiologic and clinical failure has been reported(26–28).

Candida isolates with multidrug resistance

Resistance to multiple drug classes is also an issue in some non-C. albicans species. According to one study publication, 11% of fluconazole-resistant bloodstream infections were also resistant to an echinocandin(29) More recently, an increase in echinocandin-resistant C. glabrata isolates (i.e., isolates classified as intermediate or resistant) was reported in a large surveillance study conducted in four large metropolitan areas in the United States.While these findings are consistent with single-center studies, a third of the isolates that were nonsusceptible to an echinocandin were also resistant to fluconazole in this multicenter surveillance study, which included over 1300 isolates, compared to only 8.1% of the isolates that were echinocandin susceptible. The exact cause of azole and echinocandin coresistance in some C. glabrata isolates is unknown due to differences in mechanisms of action and known mechanisms of resistance. Because many patients with C. glabrata invasive candidiasis have multiple comorbidities, prior exposure to these antifungal classes may also play a role. Furthermore, isolates with a disrupted MSH2 mismatch repair gene have a hypermutable phenotype, suggesting that they are more likely to produce multidrug-resistant mutants (30).

Aspergillus resistance

Recently, azole-resistant Aspergillus species, especially A. fumigatus, have gained attention. With extended clinical exposure, itraconazole, posaconazole, voriconazole, and isavuconazole resistance can develop in Candida species. This is well-documented and can occur in patients with persistent pulmonary aspergillosis who receive azole therapy for years. 39,40 Point mutations in the CYP51A gene, which encodes the Cyp51 enzyme, generate A. fumigatus' acquired resistance. Different mutations cause resistance to voriconazole and isavuconazole, posaconazole and itraconazole, and panazole(31–32).

The establishment of azole resistance in A. fumigatus is troublesome due to restricted therapeutic options. Amphotericin B and echinocandins can cure invasive aspergillosis, but each has limits. Amphotericin B deoxycholate is associated with clinically significant nephrotoxicity, which may limit its use. Nephrotoxicity can still occur, especially with higher doses or extended administration(33) Echinocandins avoid amphotericin B's toxicities, however they're not indicated as monotherapy for invasive aspergillosis. 55 Amphotericin B and echinocandins must be given intravenously, which can be troublesome for long-term therapy(34–35)

The common drug resistance mechanisms are alteration of drug efflux,alteration of the target enzyme,alteration of the erg3 genes,alteration of the drug influx and many more similar to that of the antibiotic resistance

Frequency of mechanisms of resistance

Perea et al [36] studied matched sets of 20 fluconazole-sus-ceptible and -resistant isolates from HIV-infected patients with oropharyngeal candidiasis, presumably treated with azoles. They found overexpression of efflux pumps in 85% of resistant isolates (the frequency of overexpresssion of CDR genes and the MDR1 gene was similar), amino acid substitutions in the target enzyme lanosterol demethylase in 58%-65%, and ov-erexpression of the gene that encodes the enzyme in 35%-42%. Multiple mechanisms of resistance were found in 75% of re-sistant isolates. White et al. [37] addressed this question in a different way. They analyzed 38 random isolates, half resistant and half susceptible, and found overexpression of the CDR genes only in

(some) resistant isolates and correlated with resistance. Neither MDR1, FLU1, or ERG11 overexpression nor amino acid point mutations correlated with resistance or were found frequently in resistant isolates. The latter study [38] suggests that putative resistance mechanisms found in resistant isolates, except for CDR-encoded pumps, may not be respon-sible for the resistance and that additional mechanisms of re-sistance remain to be uncovered. Both studies suggested CDR1 and CDR2 maybe coregulated, and both reported additional data on cross-resistance to other azoles, in addition to that previously described.

Alteration of drug efflux

Altering drug efflux is a bacterial resistance mechanism (e.g., in S. pneumoniae resistance to macrolide antibiotics (36). ATP-binding cassette transporters are known to produce drug resistance. These membrane-spanning proteins have 2 ATP-binding cytoplasmic domains (36, 37). Candida CDR genes are linked to azole resistance. At least 5 CDR genes (CDR1-5). CDR1 is a Candida and Cryptococcus transporter protein that transports azoles and other medicines (38, 39). Its structure is similar to human P-glycoprotein, which causes chemotherapeutic drug resistance. Sanglard and Albertson compared C. albicans' ability to collect fluconazole. In both trials, azole-resistant strains had lower fluconazole levels. Northern blots indicated a 10-fold increase in CDR1 mRNA, indicating overexpression. Parkinson et al. (40) described fluconazole accumulation in susceptible and resistant C. glabrata isolates. The resistant isolate accumulated less fluconazole due to energy-dependent drug efflux. C. albicans mutants with a CDR1 deletion are hypersensitive to fluconazole, itraconazole, ketoconazole, terbinafine, and amorolfine. Overexpressing CDR2 confers azole resistance. Double-disrupted CDR1 and CDR2 strains were more hypersusceptible (41). Fluconazole-resistant C. albicans overexpresses MDR1 (42, 43).

In conclusion,Several harmful fungi are resistant to various antifungal drugs. Several new antifungals are under development that may be better than the current medications in overcoming antifungal resistance and avoiding unwanted effects and drug interactions. Preclinical and clinical investigations are needed to evaluate if these medicines can overcome microbiologic and clinical failure in antifungal resistance.

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NUTRITIONAL CONSIDERATIONS AND FEEDING STRATEGIES FOR OPTIMUM REPRODUCTIVE PERFORMANCE OF PREGNANT GILTS AND SOWS

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INTRODUCTION

Nutritional management is one of the important components of pig farming. Appropriate feeding management is one of the determiners of profitability and sustainability of piggery becausefeeding alone accounts for nearly 2/3rd of the total expenditure in piggery. Proper feeding of pregnant gilts or sows is very important as it affects the litter size at farrowing, survival of piglets at weaning and numbers of pigs available for sale at marketing age. Balanced feeding during the pregnancy period enables the sows or gilts to give birth of healthy piglets.Gestational nutrition prepares the sows or gilts for successful reproduction. Deficient feeding and nutritional imbalances during pregnancy negatively affect reproduction and productivity of sows. Proper feeding management of pregnant gilts and sows is a challenge and needs continuous assessment to fulfil their nutritional requirements.

Important considerations fornutritional management of pregnant gilts or sows

- Feeding of a balanced ration at right amount.
- Avoid negative energy balance during gestation.
- Feeding of sows or gilts individually.
- Availability of quality drinking water *ad libitum*.
- Provision for quality pastures or cultivated roughages.
- Controlling excessive intakes of grains to avoid acidosis.
- Regular exercise of pregnant sows or gilts.
- Controlling of parasitic infestations.

Nutritional requirements of pregnant sows and gilts

The feeding standard of ICAR (2013) can be followed for nutritional requirements of pregnant gilts or sows. ICAR (2013) feeding recommendationsdivides the gestation period of pigs into two phases – from day 1 to 75 days of gestation and 75 to 114 days of gestation. The nutritional recommendations given by ICAR (2013) for crossbred pregnant gilts are listed in table 1.

Formulation of rations for pregnant sows and gilts

Ration formulation for pregnant sows and gilts involves understanding of their feeding behavior, having knowledge about their nutritional requirements, information about the available feed resources and their nutritional composition and most importantly, understanding about the methods of ration formulation. Commercial feed formulation software can also be used for ration formulation. However, these software needs inputs like feed ingredients available to incorporate for ra-

tion formulation, cost of the feed ingredients and nutritional composition of the feed ingredients. Farmers can utilize both the conventional feed ingredients and the unconventional feed ingredients for ration formulation of pigs. However, availability of unconventional feed ingredients are region and season specific and there is no specific standard about their inclusion levels in the rations.In most of the places, their utilization for feeding animalsis mainly based on farmer's knowledge about their suitability for feeding to the pigs. Moreover, the unconventional feed ingredients should be used with cautions as most of them contain toxic compounds (anti-nutritional factors) which can negatively affects feed utilization, nutritional status, health condition and productivity of pigs.Consumption of some anti-nutritional factors may also cause abortion and reproductive abnormality. Unless adequate information is available about suitability of their use, safe level of incorporation with the conventional feed ingredients and their nutritional composition, the unconventional feeds should not only be avoided for feeding to pregnant gilts and sows, but also other categories of pigs as well.

Conventional feed ingredients include the cereal grains (yellow maize, wheat, rice etc.) and their by-products (wheat bran, rice bran, rice polish, de-oiled rice bran etc.), oil seed cakes (de-oiled soyabean flakes, ground nut cake, sesame cake, mustard oil cakes etc.), animal origin protein rich feed ingredients (fish meal, meat meal, meat-cum-bone meal etc.), the feed additives (probiotics, enzymes, prebiotics, immune-modulator, growth promoters etc.) and the feed supplements (mineral mixture, vitamin mixture, calcium-phosphorous supplements, synthetic lysine, methionine etc.). These ingredients, depending of their availability, can be utilized for incorporating in the rations of pregnant gilts and sows. The farmers may take advise of the local Veterinarian or Animal Nutritionist to formulate rations for the pregnant gilts and sows. When facilities are not available for preparation of compounded feed by their own, farmers may utilize the commercially available gestational pig feeds.

As a thumb rule, the farmers may adopt the following guideline for ration formulation of pregnant gilts and sows using the locally available conventional feed ingredients.

Table 1: Nutritional needs of pregnant crossbred gilts.

Feed intake/body weight/nutrients	Days of gestation	
	0 to 75 days	75 to 114 days
Body weight (kg)	78 – 112	120 – 130
Daily feed intake (kg)	2.20	2.50
Protein (Crude protein %)	18.84	18.92
Energy (ME Kcal/kg)	3300	3280
Lysine (%)	0.80	0.83
Methionine (%)	0.65	0.70
Threonine (%)	0.70	0.72
Tryptophan (%)	0.21	0.22
Cysteine (%)	0.34	0.35

Feeding guidelinesfor pregnant gilts or sows

The feeding phases of pregnant gilts or sows can be divided into three –

- Phase I: 0- 35 days of pregnancy
- Phase II: 36-70 days of pregnancy
- Phase III: 71-109 days of pregnancy

Proper feeding during phase I is very im-

Table 2: Ration formulation thumb rule for pregnant gilts or sows.

Feed ingredients to be used	Kg/100 kg ration
Cereal grain (Crushed yellow maize/ broken wheat/ broken rice)	50
Oil cake (de-oiled soyabean flakes/ ground nut oil cake/ sesame oil cake/ linseed oil cake)	20
Cereal by-product (wheat bran/ rice bran)	18
Molasses	5
Fish meal/ meat meal/ skim milk powder/ dairy wastes	5
Mineral mixture	1.5
Common salt	0.5

portant because improper feeding may lead to embryo reabsorption and negatively affect health. Adequate feeding during phase II will prepare the pregnant sows or gilts for the next lactation and help to recover body condition. Excessive fat deposition during this phase is not desirable as it may affect embryo survival or the fetuses. Deposition of fats in the mammary gland also reduces milk production in subsequent lactation. Feeding during the phase III is very critical becauseduring this period there will be maximum development of the fetuses. The sows or gilts should get required nutrients from feed for maintenance of her body, body weight gain and also to support the growth of the developing fetuses. Proper feeding also ensures that mammary gland will be ready for the next lactation. Negative nutrient balance, particularly of energy, will increase the catabolic processes within the body for which pregnant sows or gild will lose condition.

The requirements of feeds i.e., amount of feed to be provided during the gestation period depends on the stage of gestation. The gestation period may be divided into the following four phases for deciding optimal amount of feed to be provided to them.

- The first 0-4 weeks of gestation.
- The following 5-11 weeks of gestation.
- The 12-15 weeks of gestation.
- The final week of gestation.

During the first week after servicing, the gilt or sow should be provided feed at the rate of 2 kg/day to avoid the risk of abortion. From 8th day onwards, amount of feed may be gradually increased to 2.5 kg per day to supply some extra nutrients to help in recovering from any loss of body condition and to allow the young gilts to grow. Following this period, feed supply may be reduced to 2.2 kg per animal per day in older sows as the fetuses will be still small and the maintenance requirement will be less. However, young gilts and second lactation sows should be provided feed at 2.5 kg per animal per day. During the 12 to 15 weeks of gestation, feed allowance should be increased to 2.5 kg per animal per day for older sows and up to 2.8 kg per animal per day in case of gilts and younger sows. The increase in late gestation feed allowance will supply the extra nutrients to support the growing fetuses and to avoid excessive sow fatness at farrowing.

In the last week of gestation, feed allowance should be reduced to 1.5kg/head/day and wheat bran or rice bran should be included up to 1.5kg/head/day to increase bulkiness and to help to avoid constipation problem. This practice will ease the delivery of piglets and will stimulate the sows to eat more after giving birth.

Feeding during transition period

Prior to farrowing, the gilt or sow should be fed concentrate feed and wheat bran/ rice bran (1:1 ratio) together. Quality drinking water should

be available *ad libitum* and preferably, lukewarm water should be provided. Immediately after farrowing also, depending on gilt's /sow's appetite, bulky feed may be offered @ 0.5 to 1.0 kg, and it should be increased gradually so that the gilt/ sow can be full fed by the end of first week of farrowing.

Effect of poor feeding management during pregnancy

Improper feeding strategy during pregnancy will result either malnutrition or overweight of pregnant gilt or sow, both of which have negative effects on piglet health and reproductive performance of gilts or sows. Both under- and over-feeding should be avoided. Improper feeding of gilts or sows during pregnancy also predisposes longer calving interval in the subsequent reproductive cycles.

CONCLUSION

Feeding is one of the most important components of any animal production system playing significant role in their developmental and productive stage. Pregnant gilts or sows are the most important components in piggery as they provide the piglets. It is necessary, therefore, to provide balanced feed at right time and quantity to them to meet the gestational requirements. Inadequate feeding causes health problems in pregnant gilt/sow seriously affecting reproduction. Strategies to optimize feeding process can ensure production under the highest standards of animal welfare.

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MINERAL PROFILE OF TESTICULAR TISSUE OF SPITI HORSE

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ABSTRACT

The paper presents mineral composition of testis of Spiti horse. The testicular tissue samples were collected from 10 apparently healthy Spiti horses immediately after castration and were digested for quantitative analysis. Different macro (magnesium, calcium, sodium and potassium) and micro (iron, copper and zinc) minerals were estimated by atomic absorption spectrophotometer and the values of sodium and potassium were estimated by flame photometry.

KEY WORDS

Spiti horses, testicular, Macro and micro minerals

INTRODUCTION

Spiti (synonym – Chamurthi) breed is one of the six recognized breeds of horses in India. It is classified under the category of pony (Hermsen, 2000). They are mainly raised on pastures and are stall fed during winters. Dietary deficiency of minerals results in poor reproductive performance leading to infertility, late puberty and breeding problems in animals (Sikka, 1972; Underwood, 1977 and Mc Dowell, 1992).Very little work has been done regarding the mineral profile in testicular tissue of this breed of horse; hence, the present work was planned and carried out to document the normal levels of some important macro and micro minerals.

Materials and Methods

Testicular tissue samples were collected from 10 apparently healthy Spiti horses immediately after castration at the clinical complex (Veterinary College Palampur), other veterinary hospitals of the state and from clinical camps organised at tribal areas of H.P. The samples collected were placed in aluminum foil and dried at 60ºC until they attained uniform weight.

Different macro (magnesium, calcium, sodium and potassium) and micro (iron, copper and zinc) minerals were estimated by atomic absorption spectrophotometer as described by Ludmilla (1976) and the values of sodium and potassium were estimated by flame photometry. The tissues (0.5gm) were digested for quantitative analysis in di-acid (15ml mixture of concentrated nitric acid and 70% perchloric acid in the ratio of 4:1) at 100°C in a conical flask. The residue left after digestion was reconstituted in known volume of demineralised water (dilution 1:20) and stored in plastic vials at room temperature till analysis.

Results and Discussion

Under nutrition poses adverse effect on the reproductive capacity of males. The restriction of nutrient intake or deficiency of particular nutrients in animals delays sexual maturity and causes rapid regressive changes in male accessory organs. Therefore, successful reproduction requires complete provisions of macro- and micronutrients (Cheah and Yang, 2011).

The mean concentration of zinc in testicular tissue of Spiti horses is 97.08 ± 4.31 µg / g. Zinc plays several roles in the male reproductive system; one of them is its participation in ribo-

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nuclease activity which is highly active during the mitosis of spermatogonia and meiosis of spermatocytes (Cheah and Yang, 2011) and enhances sperm motility (Hidiroglou and Knipfel, 1984). Since the concentration of zinc is so high in male sex organs like prostate, testicles and in the spermatozoa itself, its important role in reproduction is undeniable (Oliveira et al., 2004). Zinc is not only involved in anatomical development and normal function of male reproductive organs, but also enhances spermatogenesis by actively participating in the maturation of spermatozoa and the preservation of germinative epithelia (Cheah and Yang, 2011). Zinc deficiency in male causes atrophy of seminiferous tubule and inefficient testicular development in young ones, leading to reduced testicular size, lack of libido and can adversely affect spermatogenesis (Mass, 1987 and Kumar, 2003).

The mean concentration of iron in testicular tissue of Spiti horses is 199.77 ± 19.82 µg / g. It is required for the synthesis of hemoglobin and myoglobin as well as many enzymes and cytochrome enzymes of electron transport chain. Deficiency in adult animals is rare due to its ubiquitous presence in the feed stuffs. The reproductive performance of iron deficient animals may be badly affected due to anemia, reduced appetite and lower body condition.Well known for its significance for DNA, RNA and amino acid (cysteine, methionine) synthesis, folate is an essential micronutrient for the development of germ cells (Ebisch et al., 2006; Young et al., 2008 and Cheah and Yang, 2011).

The mean concentration of copper in testicular tissue of Spiti horses is 9.57 ± 0.75 µg/g. It is a vital component in many enzyme systems as cofactors. Cytochrome oxidase is a cupro-enzyme necessary for electron transport in mitochondria for energy metabolism of ATP dependent biosynthetic reactions (Tuormaa, 2000). Copper acts on the pituitary receptors which control the release of LH. Cu is necessary for production of melanin pigment and interaction of copper and estrogen are also observed (Hidiroglou, 1979). In males, copper deficiency leads to decreased libido, lower semen quality, and severe damage of testicular tissue may render the bull sterile (Kreplin, 1992).

The mean concentration of sodium in testicular tissue of Spiti horses is 361.20 ± 61.09 mEq/l. Sodium maintains the acidic luminal environment for sperm maturation and storage. Animal exposure to high salts increases the oxidative stress and induces the injury of the sperms and consequently reducing the reproductive performance in males (Sameh et al., 2020). In prepubertal male sheep Lins et al. (2018) mentioned, that water salinity at different levels had no significant effect on scrotal indices, but the moderate level of salt in drinking water of prepubertal male sheep exhibited beneficial influences on sperm function such as sperm motility, concentration, and vigor where as high salt in diet or water could reduce the spermatogenesis and alter the testicular morphology leading to reduced fertility in male animals. Furthermore, high salt diet reduces the synthesis of testosterone, FSH, LH, and leptin (Sameh et al., 2020).

The mean concentration of potassium in testicular tissue of Spiti horses is 255.78 ± 23.77 mEq/l. Bellentani et al., (2011) stated that transport of sperm through the epididymis is achieved by hydrostatic pressure and by smooth muscle contractions of the epididymis and it has been reported that voltage-gated K+ channels play a role in the control of smooth muscle contraction. (Santi et al., 2013).

The mean concentration of calcium in testicular tissue of Spiti horses is 0.09 ± 0.01mg/g. Ca2+ is responsible for the polarization and depolarization of the myofibrils of flagella, which can lead to sperm movement (Lins et al., 2018). Moreover, these ions are imperative for sperm motility, metabolism, acrosome reaction, hyper activated motility, and fertilization (Rahman et al., 2014).

The mean concentration of magnesium in testicular tissue of Spiti horses is 1.12 ± 0.13 mg/g. Magnesium is an essential ion involved in multiple fundamental physiologic functions (Barbagallo and Dominguez, 2010). As part of the activated

MgATP complex, magnesium is involved in the pathways generating adenosine triphosphate (ATP) and energy in mitochondria, electron transport chain and complex subunits, and oxygen detoxification (Maggio et al., 2014). Maggio et al., 2014 found that magnesium exerts a positive influence on anabolic hormonal status, including Testosterone. In a research about effects of multiple trace metals on semen quality, Mg in seminal plasma significantly affects sperm concentration, but not motility (Cheah and Yang, 2011)

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EDIBLE INSECTS AND THEIR BENEFITS

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INTRODUCTION

The last few decades have witnessed a logarithmic increase in population and are expected to reach 9.7 billion globally by 2050 (UN, 2019). On the other hand, projected livestock production would reach to 455 million tons in 2050 which is 40% higher than the reported number in 2019. (Gerber *et al.*, 2019). Currently, livestock production contributes to 14.5% of anthropogenic greenhouse gas (GHG) emissions. In particular, livestock production releases methane and nitrous oxide gases, which have higher global warming potential than carbon dioxide (Bohnes and Laurent, 2021). Alarmingly, global warming is gradually decreasing the areas used for food production worldwide (Dobermann *et al*., 2017). The water and land requirements for livestock production led to environmental footprints. Climate issues are a matter of great urgency and to ensure food availability in an environmentally sustainable manner many more radical solutions may be necessary.

Such food security and environmental concerns are propelling exploration into the concept of alternative protein to substitute or replace conventional meat proteins with other protein sources that require less intensive production means. One of the finest novel protein sources is insect protein, which has gained interest from researchers and the food industry in the past few years.

It is estimated that insects and insect-based products are eaten by almost 2 billion people. As per Food and Agriculture Organization (FAO) about 1900 insect species are used as food products (Van *et al*., 2013). Insects are institutionally accepted as a food historically consumed (Murefu*et al*., 2019).Commonly consumed insects are beetles, caterpillars, bees, ants, crickets, grasshoppers, and locusts (Raheem *et al*., 2018). Insects have a higher market value than other protein sources (Dobermann *et al*., 2017).FAO has begun promoting insects as viable dietary options for humans (Van *et al*., 2013). The edible-insect market is expected to exceed approximately USD 8 billion by 2030 globally (Globe Newswire, 2019).As of 2017, crickets (house cricket and field cricket) occupies the largest share in the global edible insect market.

Advantages of Insect consumption (De Carvalho *et al*., 2020)

- High protein content with high PCDAAS

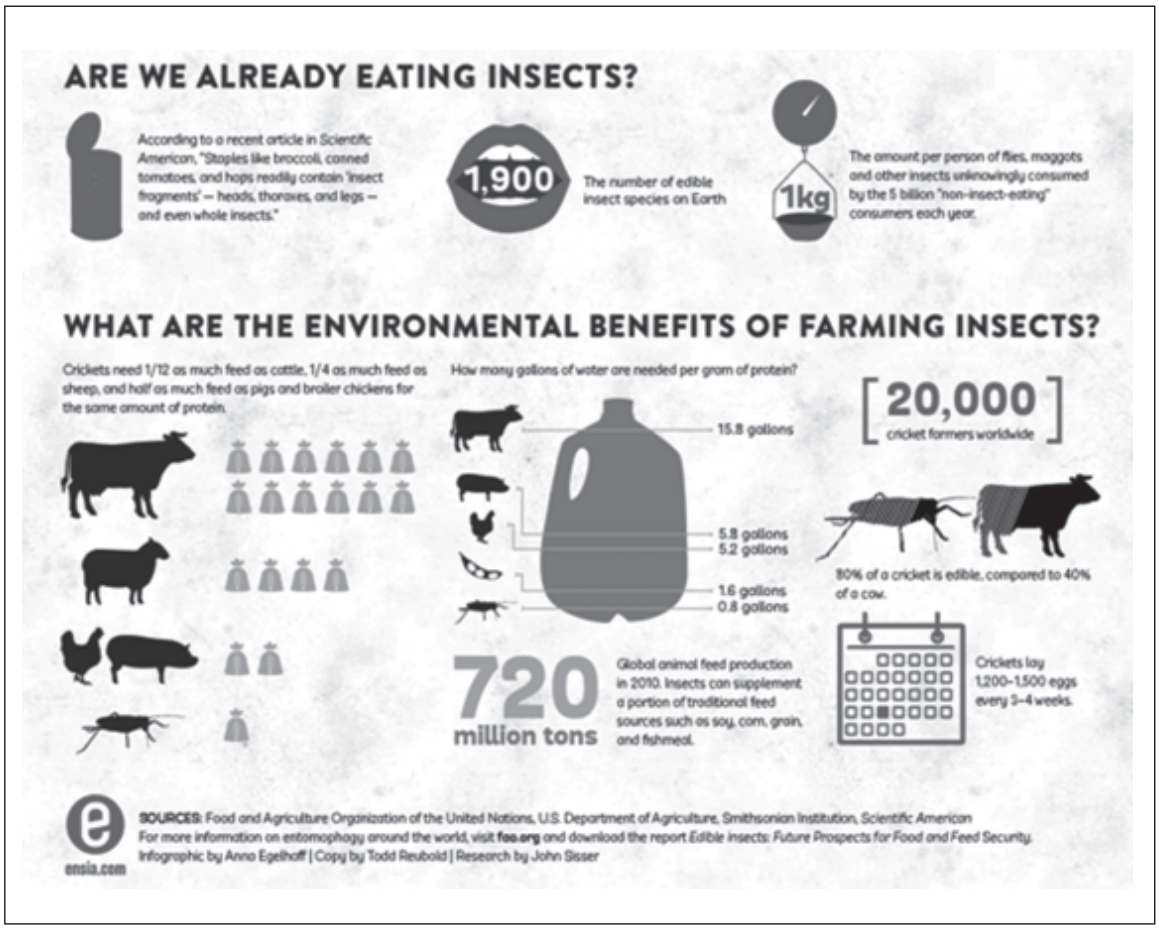

Fig. 1: *Benefits of insects (FAO, 2020)*

- Presence of all Essential Amino Acids
- High Vitamin and mineral content
- Less water and land requirements for insect farming
- Low water pollution
- Less Greenhouse gases emission
- Reduction in pesticide usage
- Short reproduction cycle
- High growth rate
- High feed conversion ratio
- Sustainability to environment

Nutritional composition of insects

Edible insects in Orthoptera (crickets, grasshoppers, locusts) are particularly protein-rich (Rumpold and Schlüter, 2013). However, insect protein digestibility is highly variable due to the presence of a hard exoskeleton (Van, 2016). Many insect species were found to have high protein content, crickets were determined to have a higher protein quality and digestibility (measured as protein digestibility-corrected amino acid score or PDCAAS) as compared to the others (Oibiokpa *et al*., 2018)Exoskeletons with a high proportion of chitin components are especially difficult to digest (Schluter *et al.,* 2017). Some insects (e.g., grasshoppers, crickets, termites, and mealworms) are rich in iron,zinc, calcium, copper, phosphorus, magnesium, and manganese. (De Castro *et al*., 2018).

Other applications of Insects

Animal Feed: Insect meal, fish meal and soybean meal are quite similar in their amino acid profiles (Pinotti *et al*., 2019).Globally the market

Table 1. **Nutrition composition of edible insects (based on dry matter)**

Type of insects	Scientific name	Protein content (%)	Fat content (%)	Carbohydrates content (%)	Reference
Larvae	*Allomyrina dichotoma*	54.18	20.24	-[1]	Ghosh et al. (2017)
	Anaphe infracta	20.00	15.20	-	Banjo et al. (2006)
	Anaphe recticulata	23.00	10.20	-	Banjo et al. (2006)
	Anaphe venata	25.70	23.21	-	Banjo et al. (2006)
	Gonimbrasia belina	56.95	10.00	7.80	Siulapwa et al. (2012)
	Gynanisa maja	55.92	12.10	10.70	Siulapwa et al. (2012)
	Protaetia brevitarsis	44.23	15.36	-	Ghosh et al. (2017)
	Rhynchophorus phoenicis	22.06	66.61	5.53	Ekpo and Onigbinde (2005)
	Tenebrio molitor	46.44	32.70	-	Ravzanaadii et al. (2012)
Beetle	*Heteroligus meles*	38.10	32.01	20.10	Jonathan (2012)
	Oryctes boas	26.00	1.50	-	Banjo et al. (2006)
	Rhynchophorus phoenicis	50.01	21.12	20.23	Jonathan (2012)
	Rhynchophorus phoenicis	28.42	31.40	-	Banjo et al. (2006)
Grasshopper	*Ruspolia differens*	44.59	49.00	8.40	Siulapwa et al. (2012)
	Zonocerus variegatus	26.80	3.80	-	Banjo et al. (2006)
Cricket	*Brachytypes* spp.	6.25	2.34	-	Banjo et al. (2006)
	Gryllus bimaculatus	58.32	11.88	-	Ghosh et al. (2017)
	Teleogryllus emma	55.65	25.14	-	Ghosh et al. (2017)
Termites	*Macrotermes bellicosus*	20.10	28.20	-	Banjo et al. (2006)
	Macrotermes falciger	43.26	43.00	32.80	Siulapwa et al. (2012)
	Macrotermes notalensis	22.10	22.50	-	Banjo et al. (2006)
Bee	*Apis mellifera*	21.00	12.30	-	Banjo et al. (2006)
Dragonfly	*Aeschna multicolor*	54.24	16.72	-	Ramos-Elorduy et al. (1998)
	Anax sp.	26.22	22.93	-	Ramos-Elorduy et al. (1998)

Source: *Kim et al., 2019*

for insects as feed is expected to reach $1.4 billion by 2024.(Globe Newswire, 2020). Mostly insect meal used as foods for pets. Black soldier flies and yellow mealworms are commonly used insect species for animal feed. (Ipema *et al.,* 2020).

Waste Management: Insects can be used to recycle low-quality plant-derived side streams and animal excreta (manure) into high-value biomass (Zhang *et al*., 2019). Yellow mealworms and super worms can also degrade materials like styrofoam and other forms of polystyrene as well as polyethylene (Koh *et al*., 2020).

Frass as fertilizers: Yellow mealworm larvae may be a sustainable source of fertilizer (Houben *et al.* 2020).

Others: Producing biofuel, as well as chitin and lipids, which have uses in food, textiles, cosmetics, pharmaceuticals and as surfactants (Verheyen *et al.,* 2020).

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PURCHASE, STORAGE AND COOKING METHODS OF MEAT

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INTRODUCTION

Food is a common vehicle for the transmission of biological and chemical contaminants to human populations. The potential for food to become contaminated with microorganisms and chemical substances starts from the time it is harvested and continues right through until the time it is consumed. Poor or inadequate production and handling practices is the major cause for contamination of food.

Consumption of contaminated food cause foodborne illness, often called "food poisoning". Vomiting, diarrhea, and abdominal pain – and flu-like symptoms, such as fever, headache, and body acheare the major symptoms of foodborne illness. Illness due to contaminated food was perhaps the most widespread health problem in the contemporary world, and an important cause of reduced economic productivity.

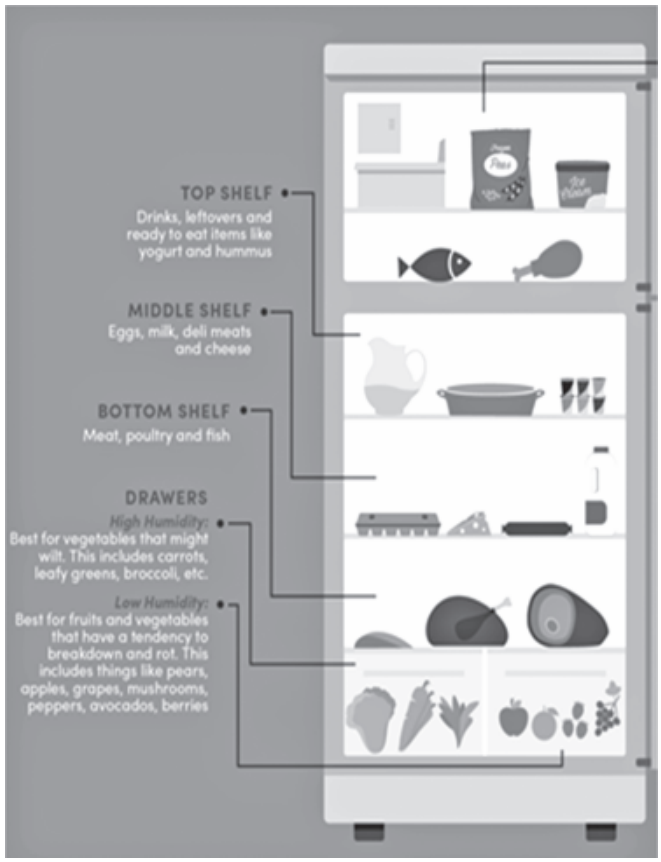
Meat is one of the high risk commodities for microbial and chemical substances contamination.Most of the food borne illness can be prevented through some simple food handling and storage steps. As the consumer is the final element in the food chain, it is important for consumers to learn about food safety at each step, from purchase till cooking and storing leftovers to avoid food borne illness.This publication provides some simple guidelines to be followed from point of purchase to serving for safe handling of meats.

METHOD OF PURCHASE OF MEAT

- Always purchase meat from hygienically maintained retail shops/ markets. Fresh meat should be firm and have uniform color. The natural colour of fresh meat, except poultry meat, is dark red, caused by the muscle pigment, myoglobin. Meat with discolored spots should be avoided as discoloration can be a sign of poor handling or poor quality meat. Similarly meat with slimy surface or abnormal odor should not be purchased.
- While shopping groceries, purchase meat, poultry and eggs after selecting non perishable items.
- Don't buy or use meat or meat productsafter its "UseBy" or "Best before"dates.
- Smart packaging, in which dye-based sensors are integrated within the package to monitor the meat quality. The intelligent sensor changes it

color if the meat within the pack is spoiled or to be used immediately.

- Never choose meat or poultry with packaging that is torn or leaking. Make sure frozen meat is deep frozen (solid) and chilled (refrigerated) meat feels cold.
- Keep raw meat wrapped in food grade packaging material and separate from other foods to eliminate the possibility of cross contamination.



STORAGE OF MEAT

- Cold temperatures reduce the growth of bacteria. Refrigerate (below 5°C) them at promptly after purchase and store until you are ready to cook. Verify the temperature of refrigerator and freezer with an appliance thermometer.
- Raw meat, poultry or seafood should be placed in containers or sealed plastic bags to prevent their juices from dripping onto other food in the refrigerator.
- Freezing is the best method to keep uncooked meat for longer duration (beyond 3 days). Freezing helps to retain nutrients and keep food fresh for at least several months. Seal the meat in an airtight package before freezing.
- Allow sufficient gap between packets in freezer for free flow of air between them. Do not overload the freezer either. Place new items toward the back of the freezer — that way, older items will be easier to access.
- Store canned food and other shelf-stable products in a cool, clean, dry place.
- Refrigerate (or freeze) leftovers within 2 hours in clean, shallow, covered containers to prevent harmful bacteria from multiplying.Dividing large quantities into smaller portions or pack meat in shallow container speed up the cooling process.
- Eating quality of the meat that was cooked immediately after slaughter could not be more palatable when compare to those meat which was cooked after keeping at least 4 hoursin refrigerator (50C) for completion of rigor mortis (process of stiffening of muscle). Keeping chicken carcass in a refrigerator for about 4 hours let to resolution of rigor mortis. This aging/conditioning process results in meat with improved tenderness, juiciness and flavor. Therefore, chicken should be kept in

refrigerator for 'aging' for at least 4 hours before cooking.

PRECAUTIONARY MEASURES BEFORE COOKING OF MEAT

- It is always necessary to clean and sanitize hands, cutting boards, utensils and countertops properly before preparation.
- It is recommended to keep raw and cooked meat separate to reduce the risk of transfer of bacteria from raw meat or poultry to cooked meat products. Hence use separate cutting board,utensils and containers for raw and cooked food, unless they are thoroughly cleaned and sanitized between uses.
- All frozen meat must be thawed completely before cooking. Do not defrost frozen meat and poultry products at room temperature.
- There are three recommended ways to thaw the meat.
  - Keeping the frozen meat with its original wrap/ in a closed container in the lowest shelfof refrigerator is the safest method to thaw. Keeping the products cold during defrosting is the key to prevent bacterial growth.
  - When defrosting in a microwave, meat should be loosely covered and the pieces turned, separated and rotated several times during thawing to ensure even heat penetration.
  - Cold water is a faster method of thawing outside the refrigerator. Place the meat in a leak-proof container/bag and submerge in cold tap water. Change the water every 30 minutes. Cook it immediately. Do not refreeze.
- Always marinate meat in a covered dishin the refrigerator, not on the counter.

METHOD OF COOKING AND SERVING

- Cooking temperature affects both the taste and safety of food. Thorough cooking will destroy most of the harmful bacteria present in the meat foods. Color and texture are unreliable indicators of safety. Using a food thermometer is the only way to ensure the safety of meat, poultry and seafood products. The rare to well-done spectrum refers to the temperature at the center of the meat, which is best checked using a meat thermometer. From a safety perspective, hotter temperatures at the center of the meat are safer. Typical cooking temperatures are:
  - Rare: 48.9–51.7 °C
  - Medium: 60–62.8 °C
  - Well-done: 73.9°C or higher
- Avoid interrupted cooking. Never partially cook meat, poultry or seafood to later finish them on the grill or in the oven.When cooking meat, make sure it is cooked to minimum 70°C and that no pink coloredmeat remains.
- For microwave cooking, always follow the manufacturer's microwave

instructions thoroughly. Arrange food evenly to ensure uniform cooking. Stir, rotate or turn foods midway during the process to eliminate any possible 'cold spots'.Always allow standing time, which completes the cooking.Food thawed in cold water or in the microwave should be cooked immediately.

- As bacteria that cause food-borne illness grow rapidly at room temperature, cooked meat should not be left at room temperature for more than 2 hours and at refrigerated storage (below 5°C)for no longer than 2 days.
- When reheating leftovers, reheat thoroughly to a temperature of 75 °C or until hot and steamy. Bring soup, sauce and gravies to a rolling boil.
- Use clean dishes and utensils to serve meat or other food products, not those used in preparation.
- Replace sponges and kitchen towels regularly. Washing your dishes and cutting boards with dirty sponges and towels can spread more bacteria. Bacteria and other disease causing pathogens also grow on sponges and towels over time, so make sure to clean your sponge thoroughly every other day and replace it about once per week.

The following chart provides general recommended storage times from date of purchase/manufacture, when stored under optimum conditions. If a product has a "use by"/ "best before date", follow that date.

Meat Foods	Refrigerator (4° C)	Freezer (-18° C)
Fresh Meat (Beef, Lamb& Pork)		
Steaks	3 to 5 days	6 to 12 months
Chops	3 to 5 days	4 to 6 months
Fresh Poultry		
Chicken, whole	1 to 2 days	10 to 12 months
Chicken, parts	1 to 2 days	9 months
Giblets	1 to 2 days	3 to 4 months
Fresh fish	1 to 2 days	6 months
Cooked Poultry		
Fried chicken	3 to 4 days	4 months
Cooked poultry dishes	3 to 4 days	4 to 6 months
Chicken nuggets, patties	3 to 4 days	2 months
Sausage, raw from pork, beef, chicken	1 to 2 days	1 to 2 months
Smoked sausage, patties	7 days	1 to 2 month

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Himachal Pradesh Agri varsity installs Artificial Intelligence-based herd management system

Palampur: CSK Himachal Pradesh Agriculture University has installed sensor equipped herd monitoring system Allflex in the Livestock Farm complex.

The Allflex transmits signals on a real-time basis about the health, rumination and reproduction status of the cow. It gives alerts on the mobile phone of the staff, in case the animal is in the heat for artificial insemination or the animal is having any digestion upsets. These sensors monitor the rumination, activity and health status of animals and transmit it through a centrally located transmitter to artificial intelligence-based software, which interprets the signals on a real-time basis.

The system analyses these inputs and gives regular messages to the farm manager on his mobile phone regarding animals in estrus, prone to abortion etc. Farm managers upon getting such alerts can verify the input and take necessary steps.

Prof H.K Chaudhary, Vice-Chancellor Agriculture University informed that initially 20 cows have been equipped with neck bands.

This artificial intelligent-based health monitoring system can cover 5000 animals with an air distance of 100 meters and has been installed for the first time in the state of Himachal Pradesh for a demonstration to visiting farmers and entrepreneurs.

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