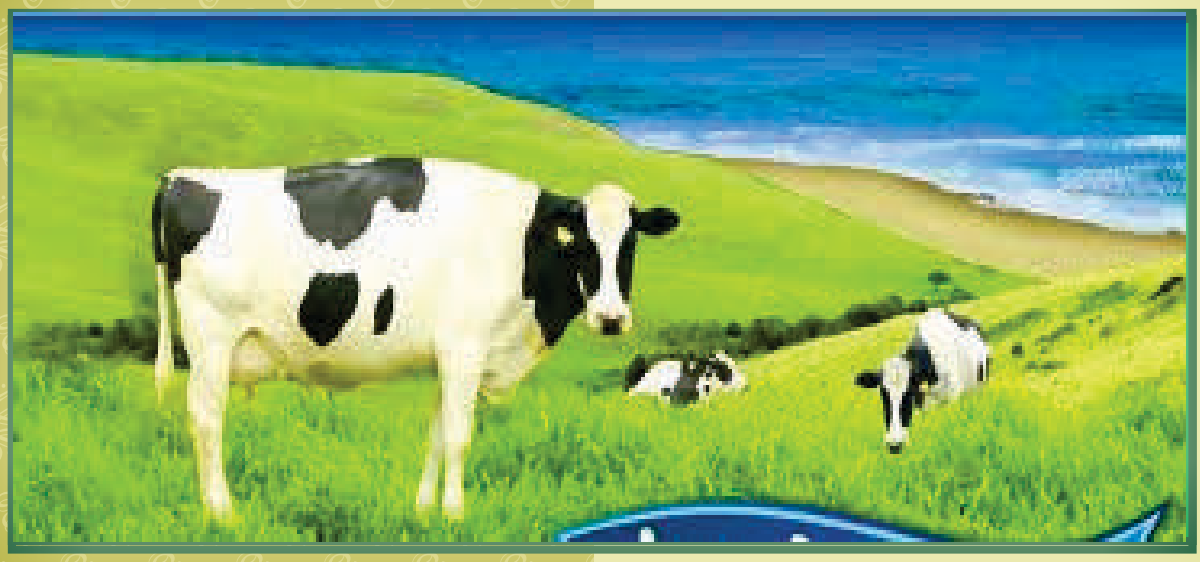
Animal Nutrition and Reproduction (Dairy Husbandry)

Practical Manual for Class-XI



CENTRAL BOARD OF SECONDARY EDUCATION

Shiksha Kendra, 2, Community Centre, Preet Vihar, Delhi-110 092 India

नया आगाज़

आज समय की माँग पर
आगाज़ नया इक होगा
निरंतर योग्यता के निर्णय से
परिणाम आकलन होगा।

परिवर्तन नियम जीवन का
नियम अब नया बनेगा
अब परिणामों के भय से
नहीं बालक कोई डरेगा

निरंतर योग्यता के निर्णय से
परिणाम आकलन होगा।

बदले शिक्षा का स्वरूप
नई खिले आशा की धूप
अब किसी कोमल-से मन पर
कोई बोझ न होगा

निरंतर योग्यता के निर्णय से
परिणाम आकलन होगा।
नई राह पर चलकर मंज़िल को हमें पाना है
इस नए प्रयास को हमने सफल बनाना है
बेहतर शिक्षा से बदले देश, ऐसे इसे अपनाए
शिक्षक, शिक्षा और शिक्षित
बस आगे बढते जाएँ
बस आगे बढते जाएँ
बस आगे बढते जाएँ.....

Animal Nutrition and Reproduction

(Dairy Husbandry)

Practical Manual for

CLASS XI

CENTRAL BOARD OF SECONDARY EDUCATION, DELHI
Shiksha Kendra, 2 Community Centre, Preet Vihar, Delhi-110092 India

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भारत का संविधान

उद्देशिका

हम, भारत के लोग, भारत को एक '[सम्पूर्ण प्रभुत्व-संपन्न समाजवादी पंथनिरपेक्ष लोकतंत्रात्मक गणराज्य] बनाने के लिए, तथा उसके समस्त नागरिकों को:

सामाजिक, आर्थिक और राजनैतिक न्याय,
विचार, अभिव्यक्ति, विश्वास, धर्म
और उपासना की स्वतंत्रता,
प्रतिष्ठा और अवसर की समता

प्राप्त कराने के लिए, तथा उन सब में, व्यक्ति की गरिमा और [2] [राष्ट्र की एकता और अखण्डता] सुनिश्चित करने वाली बंधुता बढ़ाने के लिए दृढ़संकल्प होकर अपनी इस संविधान सभा में आज तारीख 26 नवम्बर, 1949 ई॰ को एतद्द्वारा इस संविधान को अंगीकृत, अधिनियमित और आत्मार्पित करते हैं।

1. संविधान (बयालीसवां संशोधन) अधिनियम, 1976 की धारा 2 द्वारा (3.1.1977) से "प्रभुत्व-संपन्न लोकतंत्रात्मक गणराज्य" के स्थान पर प्रतिस्थापित।
2. संविधान (बयालीसवां संशोधन) अधिनियम, 1976 की धारा 2 द्वारा (3.1.1977 से), "राष्ट्र की एकता" के स्थान पर प्रतिस्थापित।

भाग 4 क

मूल कर्त्तव्य

51 क. मूल कर्त्तव्य – भारत के प्रत्येक नागरिक का यह कर्त्तव्य होगा कि वह –

(क) संविधान का पालन करे और उसके आदर्शों, संस्थाओं, राष्ट्रध्वज और राष्ट्रगान का आदर करे;

(ख) स्वतंत्रता के लिए हमारे राष्ट्रीय आंदोलन को प्रेरित करने वाले उच्च आदर्शों को हृदय में संजोए रखे और उनका पालन करे;

(ग) भारत की प्रभुता, एकता और अखंडता की रक्षा करे और उसे अक्षुण्ण रखे;

(घ) देश की रक्षा करे और आह्वान किए जाने पर राष्ट्र की सेवा करे;

(ङ) भारत के सभी लोगों में समरसता और समान भ्रातृत्व की भावना का निर्माण करे जो धर्म, भाषा और प्रदेश या वर्ग पर आधारित सभी भेदभाव से परे हों, ऐसी प्रथाओं का त्याग करे जो स्त्रियों के सम्मान के विरुद्ध हैं;

(च) हमारी सामासिक संस्कृति की गौरवशाली परंपरा का महत्त्व समझे और उसका परीक्षण करे;

(छ) प्राकृतिक पर्यावरण की जिसके अंतर्गत वन, झील, नदी, और वन्य जीव हैं, रक्षा करे और उसका संवर्धन करे तथा प्राणिमात्र के प्रति दयाभाव रखे;

(ज) वैज्ञानिक दृष्टिकोण, मानववाद और ज्ञानार्जन तथा सुधार की भावना का विकास करे;

(झ) सार्वजनिक संपत्ति को सुरक्षित रखे और हिंसा से दूर रहे;

(ञ) व्यक्तिगत और सामूहिक गतिविधियों के सभी क्षेत्रों में उत्कर्ष की ओर बढ़ने का सतत प्रयास करे जिससे राष्ट्र निरंतर बढ़ते हुए प्रयत्न और उपलब्धि की नई उंचाइयों को छू ले।

THE CONSTITUTION OF INDIA

PREAMBLE

WE, THE PEOPLE OF INDIA, having solemnly resolved to constitute India into a [1] **SOVEREIGN SOCIALIST SECULAR DEMOCRATIC REPUBLIC** and to secure to all its citizens :

JUSTICE, social, economic and political;

LIBERTY of thought, expression, belief, faith and worship;

EQUALITY of status and of opportunity; and to promote among them all

FRATERNITY assuring the dignity of the individual and the [2] [unity and integrity of the Nation];

IN OUR CONSTITUENT ASSEMBLY this twenty-sixth day of November, 1949, do **HEREBY TO OURSELVES THIS CONSTITUTION.**

1. Subs, by the Constitution (Forty-Second Amendment) Act. 1976, sec. 2, for "Sovereign Democratic Republic (w.e.f. 3.1.1977)
2. Subs, by the Constitution (Forty-Second Amendment) Act. 1976, sec. 2, for "unity of the Nation (w.e.f. 3.1.1977)

THE CONSTITUTION OF INDIA

Chapter IV A

Fundamental Duties

ARTICLE 51A

Fundamental Duties - It shall be the duty of every citizen of India-

(a) to abide by the Constitution and respect its ideals and institutions, the National Flag and the National Anthem;

(b) to cherish and follow the noble ideals which inspired our national struggle for freedom;

(c) to uphold and protect the sovereignty, unity and integrity of India;

(d) to defend the country and render national service when called upon to do so;

(e) To promote harmony and the spirit of common brotherhood amongst all the people of India transcending religious, linguistic and regional or sectional diversities; to renounce practices derogatory to the dignity of women;

(f) to value and preserve the rich heritage of our composite culture;

(g) to protect and improve the natural environment including forests, lakes, rivers, wild life and to have compassion for living creatures;

(h) to develop the scientific temper, humanism and the spirit of inquiry and reform;

(i) to safeguard public property and to abjure violence;

(j) to strive towards excellence in all spheres of individual and collective activity so that the nation constantly rises to higher levels of endeavour and achievement.

Contents

CHAPTER-1

Collection and identification of common feeds and fodders

Objectives

1. To identify concentrate feeds.
2. To identify succulent/green fodders.

Introduction

For making a balanced ration for dairy animals , various types of feed ingredients are available with farmers. These include concentrate feed ingredients (maize, barley, rice grains, wheat bran etc.), green roughages (maize, sorghum, oat, berseem, silage etc.), dry roughages (wheat straw, paddy straw etc.) etc. Therefore, they should be identified properly before their inclusion in the ration.

(I) Concentrate feed ingredients

A. Energy sources

Fig. 1. Maize grain, CP=11%, TDN=84%.

Fig. 1.2 Barley grain, CP=8%, TDN=70%.

B. Vegetable protein sources

Fig. 1.3 Groundnut cake, CP=45%, TDN=78%

Fig. 1.4. Mustard cake, CP=35%, TDN=80%

C. Agro-industrial byproducts

Fig. 1.5. Wheat bran, CP=15%, TDN=65%

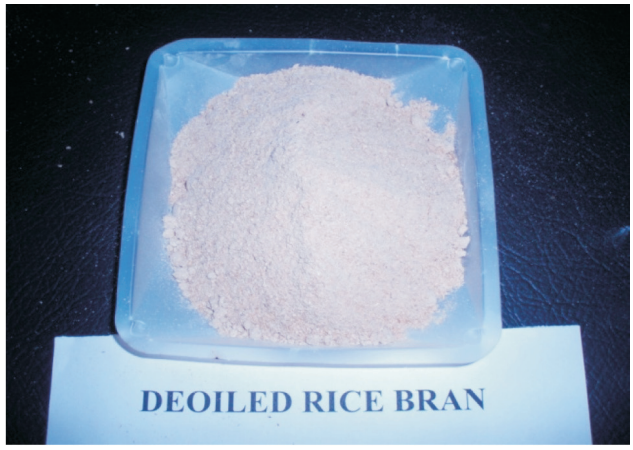


Fig. 1.6. DORB, CP=135, TDN=60%

Fig. 1.7. Compound pelleted feed, CP=20%, TDN=75%

(II) Cultivated fodders

A. Kharif season fodders

Fig. 1.8 Maize green, CP=9%, TDN=60% Fresh forage yield= 350-500q/ha

Fig. 1.9. Sorhum, CP=7%, TDN=55%, Fresh forage yield= 350-500q/ha

B. Rabi season fodders

Fig. 1.10 Oats, CP-10%, TDN=60% Fresh forage yield=250-425q/ha

Fig. 1.11. Berseem, CP=18%, TDN=62% Fresh forage yield= 500-1000q/ha

Fig. 1.12 Chinese cabbage, CP=145, TDN=60%, Fresh forage yield=200-350q/ha

Sample questions

1. Identify the given concentrate feed ingredients.
2. Identify the given roughage samples.

CHAPTER-2

Proximate analysis of feeds

Objectives

1. To know the general precautions to be observed in the laboratory.
2. To define the proximate principles.
3. To collect and process the feed samples.
4. To analyse proximate principles (moisture, total ash, crude protein, ether extract, crude fibre and nitrogen free extract) in feedstuffs.

Introduction

Hanneberg and Stohmann working at the Weende Experimental Station, Germany devised proximate principles analysis system in 1865 for routine description of animal feedstuffs. The components are: moisture, total ash, crude protein, ether extract, crude fibre and nitrogen free extract.

A. General precautions for safety in the laboratory

1. Care and cleanliness must be practised by the Laboratory personnel at all times.
2. Staff should not indulge in smoking in a laboratory.
3. Electric switches and connections should be repeatedly inspected and kept free from corrosion so that no danger shall arise from short circuiting or due to the exposure of naked wire resulting from breaking of the insulation of corrosion.
4. When a laboratory is to be left unattended for any length of time, all water tape should be turned off.
5. Proper disposal of waste from a laboratory is a problem of considerable importance. There should be an ample supply of bins of suitable sizes for disposal of solid materials such as broken glass, porcelain, filter papers, etc. The bins should be cleaned often, at least daily.
6. If corrosive/poisonous liquids are being thrown down the sink, they should be accompanied by a generous supply of water to ensure that by the time they reach the main drain they will be too dilute to be dangerous.

7. When working in a laboratory, it is better to wear some sort of protective coat, apron or overall.

8. All bottles and containers should be carefully and distinctly labeled so that no confusion or possible error can arise when several containers are being filled with different chemicals.

9. Many accidents occur in transporting bulky containers from room to room or from one part of the laboratory to another. Bottles should never be carried by the neck. Trays or polythene buckets or suitable trolley should be used.

10. Adequate and conveniently accessible storage of both apparatus and chemicals is essential to the laboratory safety. Bottles containing liquids should be kept on the lower shelves whilst solids should be kept on the upper ones.

11. The floor space should be kept free from spillage, broken glass, straw, paper etc. as their presence may lead to accidents.

12. When dealing with volatile inflammable liquids, no flames should be allowed in vicinity and care should be taken to avoid inhalation of vapours.

13. Cylinders of gases under pressure are best kept upright in a suitable stand well away from any source of heat.

14. When pouring liquids from one container into another, keep both vessels well away from the body so that any spillage shall not fall upon the person. When corrosive chemicals are involved, carry out the operation over a sink so that any spillage can be easily flushed away.

15. It is often an advantage to use a glass rod to direct the liquid stream when pouring from one bottle to another.

16. When diluting concentrated sulphuric acid, always add the acid to the water kept in ice and not vice versa. Add the acid slowly, preferably down a glass rod with stirring to reduce the violence of the reaction.

17. When NaOH is dissolved in water, a lot of heat is evolved. Use cold water and add NaOH to it little by little. Do not handle NaOH with unprotected hands.

18. When pushing a glass tube or rod through a hole in rubber cork, lubricate well with water.

19. Poisonous and offensive reagents should never be pipetted by mouth, use propipettes or bulbs.

20. It is not advisable to use glass stoppers in bottles containing KOH and NaOH. The stoppers are prone to sticking and their removal may involve breaking the neck of the bottle. Use rubber stoppers or store them in polythene containers.

21. Fire buckets containing sand and water should always be available. Fire extinguishers should be kept at readily accessible points. They should be sent for filling immediately after use.

22. In case of emergency, medical attention should be quickly obtained. Meanwhile, first aid should be given to the person. A first aid cabinet should be readily accessible and be placed in the charge of a staff member capable of dealing with an emergency.

23. Many accidents are caused by failure to seek advice or information. Never attempt to use an equipment that you have not fully understood.

24. If acid falls on clothes, neutralize the same with few drops of dilute ammonia solution or some other weak alkali solution.

25. If you happen to such acid into your mouth during pipetting, wash your mouth quickly with water and then rinse with a weak solution of washing soda.

26. Laboratory floor, working tables and water sinks should be kept neat and lean and it should be well ventilated and provided with an exhaust fan to remove unwanted gases, fumes and smoke.

27. Store chemicals and glassware in alphabetical order in well protected cupboards/ almirahs.

28. Systematic breakage record should be maintained.

29. Always use acid and alkali gloves while handling strong acids and alkalies.

30. While digesting the samples, use fume protecting face mask to avoid inhalation of highly irritating sulphur dioxide fumes.

31. Distilled water bottles should be kept tightly corked to avoid absorption of atmospheric gases.

32. While opening liquor ammonia bottles, especially during summer season, cool it for some time in a freezer to avoid sudden spurt of ammonia gas accumulated in the bottle.

33. After use of electronic balance, plateform of the balance should be cleaned with a camel hair brush, if any spillage of chemical, sample etc. was found.

34. Proper record of usage of special equipment should be made in log book meant for it showing date, time and condition of the equipment.

35. Never blow the solution left at the tip of the pipette and delivery of the reagent drawn into pipette should be uniform giving appropriate time varying from 10 to 30 sec. for quantities of 2 to 50 ml.

36. Acid and alkali spillage on working tables, floor and clothes should be thoroughly washed with water after suitably neutralizing with either weak alkali in case of acid and weak acid in case of alkali.

37. Always use double glass distilled/HPLC grade water while analyzing minerals.

38. Always use self prepared reagents and indicators.

39. Consider lower meniscus for clear and colourless solutions and upper meniscus for coloured solutions while recording observations with the help of measuring glassware.

40. During cooling samples in a desiccator, the lid should be displaced to leave a small space which can be put after cooling.

41. Do not put on fans during decarbonization of the sample for ashing. Put on the exhaust fan during decarbonization and while handling fuming acids and other chemicals.

42. Always keep decarbonized samples in a closed container like desiccator while carrying to muffle furnace, otherwise being light the material in silica basin may be displaced due to external air movements.

Cleaning of glassswares and precautions in their use

Cleaning of Glassware

1. Ordinary glassware should be thoroughly cleaned with washing soda or any detergent followed by washing with ordinary tap water and rinsing with distilled water care should be taken to remove previous markings on the glassware, if any, while cleaning.

2. Cleaning of flasks, used while estimating ether extract, should be done by slight boiling with dilute alkali (NaOH) followed by same procedure adopted for cleaning of ordinary glassware. Care, however, should be taken not to use any brush for cleaning inside the flask to avoid scratch formations.

3. Graduated glassware may be cleaned by initially keeping in chronic acid solution (Dissolve about 60 g potassium dichromate in 300 ml of water by thorough stirring and boiling to which 460 ml of concentrated sulphuric acid is added slowly after cooling) kept in jar for reasonable time followed by washing and cleaning as per ordinary glassware. Discard chromic acid solution when it develops green colour.

Drying of Glassware

1. Ordinary glassware can be dried by keeping in hot air oven at low temperature.

2. Graduated glassware (pipettes, burettes, measuring cylinders, volumetric flasks etc.)

should never be dried in hot air oven as high temperature would change the volume for which they are graduated.

Precautions in the use of burettes and micro burettes

1. The burette must be clean. When a liquid is delivered from a burette, no adhering drops should be left on the walls. If drops are formed, the burette must be thoroughly cleaned before it is used.
2. Before use, the burette should be rinsed thrice with a small volume of the solution with which it is to be filled.
3. Fill a micro burette by attaching a rubber tube to the top. Suck up the solution from a beaker held beneath the tip. Remove the rubber tube and wipe off the burette tip with a clean filter paper before adjusting the meniscus to the zero mark.
4. After filling any burette, it is essential to remove all air bubbles from the delivery tip before measurement are made.
5. Be sure that the burette delivery tip or stop cock does not leak.
6. During titrations, do not empty the burette too rapidly. Accurate measurements depend largely upon uniform drainage.
7. Make careful readings. Have your eyes level with the bottom of the meniscus. Estimate the volume to the nearest 0.01 ml on an ordinary burette and to the nearest 0.001 or 0.002 ml on a micro burette.

Precautions in the use of pipettes

1. The pipette must be clean. No drops should adhere to the walls after the pipette has been drained.
2. Before use, the pipette should be either dry or rinsed three times with small volume of the solution to be measured.
3. While filling a pipette, be sure that its tip is well below the surface of the liquid. This is extremely important when strong acids, bases, or other corrosive or poisonous solutions are handled.
4. Draw the liquid a little way above the mark, then carefully remove all drops adhering to the outside of the pipette stem by wiping with a clean piece of filter paper.
5. Adjust the meniscus of the liquid to the mark a carefully while the pipette is held vertically.
6. Hold the pipette vertically while draining it. When the liquid has ceased to run, touch

the tip of the pipette to the wall of the receiving vessel. A small drop of liquid will remain on the tip of the ordinary transfer pipette. Do not try to remove this drop. However, when using an *Ostwals* pipette, this last drop is removed by blowing through the pipette.

7. Use care to prevent contamination of the pipette tip. Support in such a manner that tip does not rest on the bench top.

8. After using, pipettes should be kept in chromic acid solution (potassium dichromate 60 g distilled water, 300 ml sulphuric acid, 460 ml) at least for overnight and then should be washed thoroughly.

Principles of preparing standard solutions

The analytical procedures of feeds in the field of avian nutrition are done both quantitatively and qualitatively. In quantitative analysis, volumetric methods are mostly used and these are solely dependent upon standard solutions. The accuracy of analytical work and hence results depends to a greater extent on the accuracy of the standard solution used.

Expression of Concentration of Standard Solutions

A standard solution is one whose strength or concentration is known with sufficient accuracy to use in volumetric analysis. The concentration of solution can be expressed in various ways such as

Weight Per unit Volume

This is the simplest way of expressing concentration of solution in which a weighed quantity is dissolved and diluted to a definite volume giving a solution containing a known weight per unit volume. In this method, number of grams or milli grams) of solute per litre (or milli litre) of solvent are used.

Per cent Composition

By this method concentration is expressed in terms of grams of solute per 100 grams of solution. A 10 per cent solution of a given salt is made by dissolving 10 grams of the sale in 90 grams of water.

Volume Ratio

Occasionally, the concentration of a mineral acid or of ammonium hydroxide is given in terms of the volume ratio of the common concentrated reagent and water. Thus H_2S0_4 (1: 3) signifies a solution made by mixing one volume of the commonly used cone H_2SO_4 (sp. Gr. 1.84) three volumes of water.

Molar Solution

A molar solution contains one mole or a gram molecular weight of the solute in one litre of solution.

Molal Solution

A molal solution contains one mole or a gram molecular weight of the solute in 1 litre of the solvent.

Normal solution

This is the most widely used method of expressing the concentration of a standard solution. A normal solution contains one gram equivalent weight per litre of solution.

In case of acids, a 1 N solution contains 1.008 gram of replaceable hydrogen per litre of solution. A 1N solution of a base is one that contains 17.008 grams of hydroxyl ions per litre. A 1N solution of the precipitating agent contains a weight of precipitating agent equivalent to 1.008 gram hydrogen.

Equivalent Weight

An equivalent weight of a substance is that weight equivalent in reacting power to an atom of hydrogen.

$$\text{Equivalent weight of an acid} = \frac{\text{Molecular weight of acid}}{\text{basicity}}$$

Basicity of an acid is equal to the number of replaceable hydrogen atoms present in the mole of the acid.

Hence,

$$\text{Eq. wt. of HCl} = \frac{36.46}{1} = 36.46$$

$$\text{Eq. wt. of } H_2SO_4 = \frac{98.08}{2} = 49.04$$

$$\text{Eq. wt. of an alkali} = \frac{\text{Molecular weight of acid}}{\text{Acidity}}$$

Acidity of an alkali is equal to the number of replaceable hydroxyl groups present in one mole of the alkali.

Hence,

$$\text{Eq. wt. of NaOH} = \frac{40.00}{1} = 40.00$$

$$\text{Eq. wt. of } Na_2Co_3 = \frac{105.00}{2} = 53.00$$

Gram equivalent weight of an oxidizing substance is that weight of the substance in grams which is equivalent to 8 g of available oxygen.

$$\text{Eq. wt. of } KMNO_4 \text{ in acidic medium} = \frac{158}{5} = 31.6$$

$$\text{Eq. wt. of } KMnO_4 \text{ in alkaline medium} = \frac{158}{3} = 52.7$$

Titration

The process of adding one solution of known strength to another unknown one so that the reaction is just completed. In titration, we find the strength of unknown solution by measuring its volume with the help of burette, pipette and measuring flask. So it is also termed as volumetric analysis.

Titre

A titre is defined as the weight of solute contained in a milli litre of solution or the weight of any substance which will react with or be equivalent to 1 ml of the solution. It is seen that the litre of a normal solution is its milli equivalent weight. The relationship between titre and normality is shown by the expression.

$$\text{Normality} = \frac{\text{Titre x 1000}}{\text{g. eq. wt. of substance in which the titre is expressed}}$$

For example, an acid solution with ah “NaOH titer of 0.0040 g” mean that ml of the acid solution neutralized 0.0040 g of NaOH.

End Point

The point at which the colour change occurs and at which the titration is just completed is called the end point (the equivalence or stoichiometric point). The end point can be found by some change in colour or a coloured precipitate developed during the reaction either by one of the reagents added or by the addition of an auxiliary reagent known as the indicator.

Indicator

The analyst must have some way of knowing when an equivalent amount of reagent has been added. This is accomplished in several ways one of which is the addition of certain substances to a solution being titrated which will be indicated by their behaviors when the end point has reached. Such substances are called indicators. Usually the indication they give is that the right amount of reagent has been added which is shown by a distinct change in colour. Indicators may be internal, external or self indicators.

Internal Indicators

These are chemical substances which are added to the volumetric flask in which titration is carried out e.g. **phenolphthalein**, methyl orange, starch etc.

They may be further divided according to the types of reactions in which they are used (1) acid-base indicators (2) precipitation indicators (3) redox indicators (4) adsorption indicators.

a. **Acid-base Indicators**: The indicators used in acidimetry and alkalimetry are either weak organic acids (indicator aids) or weak organic bases (indicators bases), the dissociated form of which has a colour different from that of the undissociated form. A basic indicator must possess a coloured cation while an acid indicator must possess a coloured anion. Eg.: methyl orange, methyl red, phenolphthalein etc.

b. **Precipitation indicators**: They are employed in the fractional precipitation of two insoluble salts by the same reagent, e.g. in the case of silver nitrate-sodium chloride titration, potassium chromate is used as a precipitation indicator

c. **Redox indicators:** An oxidation-reduction (redox) indicator should mark the sudden change in the oxidation potential in the neighbourhood of the equivalence point in an oxidation-reduction titration. e.g. orthophenanthroline ferrous ion.

d. **Adsorption indicators:** Are those substances which adsorb certain ions at the equivalence point and a typical orientation is developed at the surface which gives a characteristic colour change indicating the end point e.g. flourescein, cosin, rhodamine etc.

Some Common Indicators

Methyl Orange

It is the sodium salt of dimethy-l-aminobenzene sulphonic acid. For the preparation of the indicator solution, 0.1 g of methyl orange is dissolved in 100 ml solution to be titrated. The colour change is from pink (acidic) to yellow (basic). Its pH ranges from 3.1 to 4.4. It is especially useful in titrating sodium carbonate with strong acids.

Methyl Red

It is dimethyl aminozobenzene -o- carboxylic acid. An indicator solution is prepared by dissolving 0.1 g of methyl red in 60 ml of alcohol after which 40 ml distilled water is added. Its colour change is from pink (acidic) to yellow (basic).

Phenolphthalein

The indicator solution of phenolphthalein is made by dissolving 0.2 g of phenolphthalein in 100 ml of 95% ethyl alcohol. The colour change is from colourless (acidic) to pink (basic). Its pH ranges from 8.2 to 10.0. It is especially useful in titrating weak acids with strong bases.

Bromocresol Green

It is tetrabromo-n-cresol sulpho-naphthalein. A suitable indicator solution is prepared by dissolving 0.1 g of bromocresol green in 100 ml of 95% ethyl alcohol. The colour change is from yellow (acidic) to blue (basic). Its pH ranges from 3.8 to 5.4. It is suitable for the titration of ammonia which has been absorbed in boric acid as in the Kjeldahl determination of nitrogen.

Primary Standard Solution

Primary standard are used for the standardization of solutions of unknown strengths.

Properties of Primary Standard Substances

1. Substances should be obtained in high purity.
2. They should be stable at temperature required for removal of moisture.
3. They should not oxidize on standing.
4. They should neither gain or lose weight on exposure.
5. A high equivalent weight is desirable in order to reduce the percentage errors in weighing.

Examples, Borax, potassium dichromate, potassium hydrogen phathalate, potassium hydrogen iodate, sodium carbonate, sodium oxalate.

B. Definition of proximate principles in feeds

Water

The moisture is determined as the loss in weight which results from drying a known weight of feed to constant weight at 100°C. Therefore, dry matter is estimated as a part of substance that does not evaporate at 100°C. The major difference in nutritional value on as fed basis is traceable to moisture content and dry matter. Calculation of relative cost of nutritional value involves consideration of moisture content. Determination of moisture is essential in bulk purchase of feed ingredients, when the grain crop is new, the moisture in feeds is very important. Feeds containing more than 14% moisture should be stored in bulk for the danger of development of moulds/fungi as well as spontaneous combustion.

Crude Protein

The crude protein content is calculated from the nitrogen content of the feed and knowing the protein content of a feed provides an idea about the class of feed it belongs to. In this method, the feed is digested with sulphuric acid which converts all nitrogen to ammonia. This ammonia is liberated by the addition of sodium hydroxide to the digest, distilled off and collected in standard acid. The quantity so collected is determined by titration. Determination of crude protein involves multiplication of estimated nitrogen content by a factor of 6.25 based on the assumption that all the proteins contains 16% nitrogen and all nitrogen is present in form of proteins. However, both the assumptions are not true. The term crude protein does not distinguish the nitrogen contribution from true protein and non-protein nitrogenous substances like urea, uric acid, free amino acids, ammonium salts etc. Non-protein nitrogen can be calculated by subtracting true protein content from crude protein.

Ether Extract

The either extract of crude fat is determined by subjecting the feed to a continuous extraction with petroleum either (boiling point = 40° - 60°C or 60° - 80°C) for a definite period. The residue after the evaporation of solvent is called either extract. Ether extract is a source of energy and provides essential fatty acids. In addition to fat, ether extract contains waxes, organic acids, alcohols, pigments etc.

Crude Fibre

The carbohydrate of the feeds is contained in two portions, the crude fibre and nitrogen free extract. Crude fibre is determined by subjecting the residual feed from ether extraction to successive treatments with boiling acid and alkali of fixed concentration, the organic

residue is crude fibre. Crude fibre contributes to the bulkiness of feed. The crude fibre fraction contains cellulose, lignin and hemicellulose in variable proportions. Originally the crude fibre was intended to represent the indigestible portion of feed, however, a large part of it may in fact be digested by ruminants. Crude fiber estimation simulates digestion in monogastric animals than in ruminants.

Nitrogen Free Extract

Nitrogen free extract is obtained when a sum of moisture, ether extract, crude fibre, crude protein and ash (per cent) is subtracted from 100. The value of nitrogen free extract is affected by analytical errors of these five parameters as well as lack of precision in crude fibre determination in separating functional categories of carbohydrates. The NFE content is inversely related to protein in concentrate feeds.

Ash

The ash content is determined by ignition of a known weight of feed at 550° - 600°C. The residue obtained is ash and represents inorganic constituents of feeds. The ash, however, does not discriminate between the proportion of mineral matter and sand/silica due either to contamination or adulteration. The ash may contain materials of organic origin such as sulphur and phosphorus of proteins. Likewise some loss of sodium, chloride, selenium and iodine takes place on ignition. Indirectly, ash helps in calculating total carbohydrates, NFE and organic matter by difference.

C. Collection and processing of various samples for analysis

Feed Ingredients/Compounded Feeds

1. With an appropriate sampling or with a simple scoop the sample is withdrawn from the top, bottom and sides of selected bags. While selecting the number of bags following sequence may be taken into consideration.

Lot size (bags)	Selected number (bags)
Up to 50	1
51 to 100	3
101 to 300	4
301 to 500	5
501 to above	7

2. The collected material (say 1500g) is equally distributed in 2-3 lots, packed separately in clean and dry polythene bags and sealed air tight. These polythene bags may further be packed in paper bags for suitable labeling and further safety.

3. A small portion (say 100g) of sample may be ground using pestle and mortar or in an electric grinder to pass through I mm IS sieve or ASTM sieve 18 or BS sieve 16 or Tyler sieve 16. The ground sample is stored in a well stoppered glass/polythene bottle for chemical analysis.

4. The following are the approximate quantities of sample of feed taken for proximate analysis.

Parameter	Dry rough ages (g)	Grains/grains by products (g)	Oil seed cakes (g)	Animal by products (g)
Moisture	10-15	10-15	5-10	5-10
Crude protein	2-3	1.5-2	0.5-1	1-2
Crude fat	3-5	2-3	1.5-2	2-3
Crude fibre	3-5	2-3	1.5-2	2-3
Total ash	5-10	5-10	5-10	5-10

D. Determination of proximate principles

Determination of dry matter

Principle

If a sample of feed is heated and dried in a hot air oven at the temperature of boiling water (100°C ± 5 °C), the water present in feed sample escapes as vapour. The loss in weight is considered as moisture and the residue is termed as dry matter (DM).

Requirement

1. Aluminium moisture cup
2. Analytical balance
3. Desiccator
4. Hot air oven
5. Metal tongs
6. Spatula

Procedure

1. Dry aluminium moisture cup (dish) in oven at 100°C for overnight, place in desiccator, cool and weigh.
2. Weigh in duplicate 2-10 g of sample into aluminium cup and shake the cup until the contents are evenly distributed.
3. **Place the cup with lid removed in the oven and dry the contents for 12-18 hours at 100° ± 5°C.**
4. Place cover on cup and transfer to desiccator to cool. Weigh as quickly as possible. Repeat the process of heating, cooling and weighing until the difference between two successive weighing is less than one milli gram.
5. Report loss in weight as moisture and it can be calculated using the following formula.

Calculation

$$\text{Moisture per cent} = \frac{100\ (W_1 - W_2)}{W_1 - W}$$

Where, W = Wt. of moisture cup

W_1 = Wt. of moisture cup + Sample

W_2 = Wt. of moisture cup + sample after drying

DM% = 100 – Moisture.

Determination of crude protein

Principle

Crude protein constitutes a mixture of true protein and non protein nitrogenous substances and is determined by estimating nitrogen and then multiplying the nitrogen content of feed by the factor 6.25. The factor 6.25 is derived on the basis that all proteins contain 16% nitrogen.

The total nitrogen content in the feedstuff is determined by Kjeldahl method which generally consists of three steps i.e. digestion, distillation and titration. The sample is digested with concentrated sulphuric acid which hydrolyses the protein, decomposes to ammonia and finally converts all nitrogen into ammonium sulphate. The acid digest is cooled, diluted

with distilled water and distilled with strong alkali (sodium hydroxide, 40%) which liberates ammonia to be absorbed quantitatively in a known volume of standard sulphuric acid again forming ammonium sulphate. The unreacted acid is then determined by back titration with standard sodium hydroxide. Alternatively, the ammonia released during distillation can also be taken up into a boric acid solution and such ammonia is titrated with standard sulphuric acid.

Boric acid procedure saves considerable time as the boric acid is not to be standardized and there is no problem of absorbing all of the ammonia distilled from acid digest of high nitrogen samples. While estimating the nitrogen content, following reactions take place.

$$\text{Protein} + H_2SO_4 \longrightarrow CO_2 + SO_2 + NO_2 + NH_3$$

$$2\ NH_3 + H_2SO_4 \longrightarrow (NH_4)_2\ SO_4$$

Ammonium sulphate derived from feed nitrogen is converted into ammonia by adding 40% alkali.

$$(NH_4)_2\ SO_4 + 2NaOH \longrightarrow 2NH_3 + Na_2SO_4 + 2H_2O$$

Ammonia is received in boric acid solution by steam distillation. The ammonia boric acid complex (ammonium borate) is titrated with standard H_2SO_4.

$$NH_4OH + H_3BO_3 \longrightarrow NH_4B\ (OH)_4$$

$$2NH_4B\ (OH)_4 + H_2SO_4 \longrightarrow (NH4)_2\ SO_4 = 2H_3B\ O_3 + 2H_2O$$

Equipment/glasswares

1. Analytical balance
2. Beaker (100 ml or 250 ml)
3. Burette
4. Conical flask (100 ml)
5. Digestion bench/automatic digestion unit
6. Glass beads
7. Glass rods
8. Kjeldahl flask (500 ml)/digestion tube
9. Micro Kjeldahl Distillation Assembly/automatic distillation assembly
10. Measuring Cylinder

11. Metal tongs
12. Spatula
13. Wash bottle

Reagents

1. Digestion mixture: (9.5 parts potassium sulphate/sodium sulphate + 0.5 parts copper sulphate). Potassium sulphate/sodium sulphate raises the boiling point of the contents for efficient oxidation of material. Copper sulphate is added as a catalyst to speed up the reaction.
2. Boric acid/mixed/Toshiro's indicator: 10 ml of 0.1 percent methyl red indicator + 5 ml of 0.1–0.5% bromocresol green indicator + 1000 ml of 2-4% boric acid solution.

   For 0.1% methyl red, dissove 100mg of methyl red in 100 ml of ethanol (95%). For 0.1–0.5% bromocresol green, dissolve 100 mg–500 mg of bromocresol green in 100 ml of ethanol (95%). For 2-4% boric acid, dissolve 20-40 g of boric acid in one litre of hot distilled water, cool and allow to mature for 2-3 days before decanting the clear liquid.
3. NaOH solution (40%): Dissolve 400 g of NaOH pellets in one litre of distilled water, cool and then use.
4. Concentrated H_2SO_4 (AR)
5. Standard N/10 or N/100 H_2SO_4 solution.

Procedure

This method of nitrogen and crude protein determination is applicable for feed, faeces and meat samples. Micro Kjeldahl nitrogen analysis comprises three different stages viz., digestion, distillation and titration.

Digestion

1. Weight 1-2 g of sample on a piece of butter paper depending upon the protein content and transfer it into a clean and dried Kjeldahl flash/digestion tube.
2. Add 5-10 g of digestion mixture to the sample taken in flask/tube.
3. Add 20-30 ml of conc. H_2SO_4 along the neck of the flask so as to wash down any particles of the sample/digestion mixture sticking to the sides (increase the amount of H_2SO_4 by 10 ml for each gram of sample).
4. Drop a few glass beads into the flask to prevent spurting while heating.

5. Place the flask/tube in an inclined position on a digestion heater and heat it below the boiling point of the acid until frothing ceases. If the froth of a sample starts up the neck of flask, remove it from the heater to allow froth to subside the return to heater. Increase heat until the acid boils vigorously and digests for a time after mixture is clear or until oxidation is complete (about 2 to 4 hours). If any material sticks to the neck of the flask cool, wash down with a small amount of water and redigest.

6. When the end point of digestion is reached, remove the Kjeldahl flask/tube and allow it to cool.

A blank digestion should always be conducted simultaneously using all reagents in the same quantities except sample to be tested.

Distillation

Distillation process can be accomplished using micro distillation method.

Micro-Kjeldahl method

1. Dissolve the digested material in a small quantity (say 50 to 100 ml) of distilled water, transfer into a volumetric flask (100 ml or 250 ml) and then make the volume upto the mark by adding distilled water.

2. Pour 5-10 ml of aliquot in receiving part of the micro-Kjeldahl distillation apparatus, add 10-20 ml of 40% NaOH solution and then add 5 ml of distilled water to the same receiver for rinsing.

3. Take 10-20 ml of boric acid indicator in a conical flask/beaker and dip the tip of collecting tube into it. Start the cold water circulation in the condenser.

4. Heat the alkaline liquid by passing steam into it through the boiling distilled water in a flask.

5. Faint reddish colour of boric acid starts changing to green colour since the released ammonia is absorbed by boric acid indicator. Released ammonia is allowed to distil till the original volume of boric acid indicator (10-20 ml) becomes three times more (30-60 ml).

6. Remove the conical flask/beaker after rinsing the tip with a little distilled water and preserve the same for titration.

Titration

Titrate the distillate using N/10, or N/100 standard sulphuric acid solution. The end point in all the cases is light pink.

Calculation

Two atoms of nitrogen (in the form of ammonia) neutralize one molecule of sulphuric acid and form ammonium sulphate. Therefore, each ml of 1N sulphuric acid neutralized by ammonia is equivalent to 0.014 g or 14 mg nitrogen. Amount of nitrogen and crude protein per ml of sulphuric acid of different strengths may be noted from the following details.

H_2SO_4		Nitrogen		Crude Protein	
Volume (ml)	**Normality (N)**	**g**	**mg**	**g**	**mg**
1	1.000 N or 1 N	0.0140	14.00	0.08750	87.50
1	0.100 N or 1 N/10	0.0014	1.40	0.08755	8.75
1	**0.010 N or 1 N/100**	**0.00014**	**0.14**	**0.00087**	**0.87**

$$\text{Nitrogen (per cent)} = \frac{\mathbf{140 \times V \times N}}{m\ (100\text{-}M)} \quad \text{on moisture free basis}$$

Where, V = volume in ml of the standard H_2SO_4 used

N = normality of the standard used H_2SO_4 used

m = sample weight in g

M = moisture percentage

For conversion on nitrogen into crude protein

Where, CP (%) = N (%) x 6.25

CP = crude protein (%) content of feedstuff

N = total nitrogen (%) present in feedstuff

Determination of ether extract

Principle

When a sample of feed is extracted continuously with fat solvent like petroleum ether, the vapour from the ether boiling in the flask passes into the condenser where it condenses and drops back on the sample which dissolves ether soluble materials such as fat, sterols, lecithins, resins and volatile oils in the extraction flask. The

extract is termed as crude fat or ether extract (EE) because it also contains other fat like substances.

Equipment/glasswares

1. Analytical balance
2. Beaker
3. Cotton wool
4. Desiccator
5. Extraction thimble
6. Hot air oven
7. Oil flask (150-250 ml)
8. Soxhlet extraction assembly: This consists of 3 parts (a) condenser at the top (b) Soxhlet or extractor in the middle (c) receiver flask at the bottom. These three parts are assembled by means of their ground glass joints.
9. Heating mantle, provision for water supply to the condenser and electricity to sheating mantle is also to be made.

Reagent

Petroleum ether (boiling point = 40-60°C or 60-80°C)

Procedure

1. Weigh 2-5g of ground feed material on a butter paper, transfer it into an extraction thimble and plug the mouth of thimble with a piece of cotton wool. If the crude fat is to be determined directly on dry matter basis, place the thimble in a beaker and dry in oven for 6 hours at 100±1°C.
2. Weigh the empty oil flask and fill it with the petroleum ether (say 50-100 ml). Place the oil flask over the heating mantle. The amount of solvent taken is about 1.5 times the capacity of the Soxhlet extractor.
3. Introduce the extraction thimble with sample into Soxhlet extractor (middle piece) over a pad of cotton wool so that the top of thimble should be well above the siphon bend of extractor. Place the extractor alongwith the oil flask and connect it with the condenser.
4. Start the cold water circulation in condenser. Switch on the heating mantle or water bath. As soon as the ether begins to boil adjust the heat to 40-60°C or 60-80°C as per the boiling point of petroleum ether used.

5. Extract the sample for 4 hours (5 to 6 drops per second condensation) to 16 hours (2 to 3 drops per second condensation). In most of the cases 8 hours extraction is sufficient.

6. After the period of extraction, remove the thimble from extractor and recover through the extractor all the ether form the oil flask leaving only few drops of ether in it.

7. Evaporate the residual ether of oil flask on water bath and place the oil flask in hot air oven at 80-100°C for two hours, cool it in desiccator and weigh it.

8. Continue cooling and weighing of the oil flask until the difference between two successive weighings is less than one milligram. Never leave more amount of petroleum ether in the oil flask and don't keep the flask in hot air oven otherwise fire may take place. If necessary, reserve the extracted sample in the thimble for the determination of crude-fibre content.

$$\text{Ether extract, per cent on as such basis} = \frac{100\ (W_1 - W_2)}{m} \text{ or } \frac{100 \times \text{wt of ether extract}}{\text{wt. of sample}}$$

Where, W_1 = wt. in g of oil flask + extracted material

W_2 = wt. in g of empty oil flask

m = wt. in g of sample

If the thimble with sample has not been dried in hot air oven at 80-100°C for 10-12 hours prior to extraction, the crude fat (ether extract) value can be converted into dry matter basis.

$$\text{Ether extract on DM basis} = \frac{\text{Crude fat} \times \text{dry matter per cent}}{100}$$

Determination of crude fibre

Principle

When a sample of moisture and fat free feedstuff is boiled with dilute acid followed by dilute alkali, the soluble carbohydrates and proteins go into the solution and are extracted. The undissolved residue left behind represents cellulose, hemicellulose, lignin and mineral matter. The cellulose, hemicellulose and lignin put together are called crude fibre (CF). When the residue after drying and weighing is ignited, the fibre being organic in nature is burnt whereas the ash or mineral matter is left over. The fibre content is

obtained by deducting the weight of ash from the weight of the dried residue. In simple way it can also be explained that the crude fibre is determined gravimetrically as part of the substance which is left when protein, soluble carbohydrate, fat, salts and water have been removed.

In poultry feeding, the analysis of crude fibre content is very essential because the amount of crude fibre predicts the digestibility of the feedstuff. Higher the fibre content lesser will be the digestibility.

Equipment / glasswares

1. Analytical balance
2. Hot air oven
3. Hot plat heating mantle
4. Muffle furnace
5. Beaker (1000ml), tall form spoutless
6. Buchner funnel
7. Conical flask
8. Desiccator
9. Horn spatula
10. Measuring cylinder
11. Muslin cloth
12. Silica crucibles, large size
13. Suction flask with gasket
14. Suction pump
15. Wash bottle

Reagents

1. Acetone
2. Hydrochloric acid (10%)
3. Sodium hydroxide (10%)

Procedure

1. Weigh accurately about 2 g of dried feed material and extract the crude fat (ether extract) for about 8 hours with petroleum ether using Soxhlet extraction apparatus.
2. Transfer the extracted feed material into tall form spoutless beaker (1000 ml), mark the beaker for 200 ml with a marker.
3. Add 50-100 ml of boiling distilled water into the beaker, add 25 ml of H_2SO_4 (10 per cent) to the beaker and make the volume upto the mark (200 ml) with the help of distilled water. Boil the content of beaker over a hot plate for 30 minutes. In order to keep the volume constant in the tall form beaker or to check the evaporation, keep one flask filled with cold water over the beaker. Bulb condenser fitted over the beaker can also be used in lieu of round bottom flask.
4. Remove the beaker from the hot plate, filter the content through muslin cloth spread over the Buchner funnel fitted with suction pump and suction flask. Wash the residue with hot water for several times till the filtrate becomes acid free.
5. Transfer the residue (acid-free) by horn spatula from Buchner funnel to the beaker. Add 50-100 ml of boiling, distilled water, 25 ml of sodium hydroxide solution (10 per cent) and then make the final volume upto the mark with distilled water. Boil the content in beaker over the hot plate for 30 minutes. Use the round bottom flask with cold water or bulb condenser with running tap waer to maintain the constant volume in the beaker.
6. Remove the beaker form the hot plate and filter the content again through the same muslin cloth on filter flask connected to a filter pump. Wash the residue with hot water for several times till free from alkali. Wash the residue with acetone.
7. Transfer the residue to a clean dry silica crucible. Dry the crucible and contents at 100°C ± 1°C in hot air oven for complete dryness. Cool the crucible in a desiccator and weigh the crucible containing dried residue.
8. incinerate the contents of the crucible at 600°C ± 20°C for two hours in a muffle furnace until all the carbonaceous matter is burnt.
9. Remove the crucible from furnace, cool in a desiccator and weigh the crucible containing ash. The loss in weight on ignition is due to the amount of crude fibre present therein.

Calculation

$$\text{Crude fibre (per cent) on as such basis} = \frac{100\ (W_1 - W_2)}{W}$$

Where, W = wt. in g of sample

W_1 = wt. in g of crucible + residue before ashing

W_2 = wt. in g of crucible + ash

$$\text{Crude fiber (per cent) on DM basis} = \frac{\text{Crude fat x } 100}{DM}$$

When residue after fat determination is used.

$$\text{Crude fiber (per cent) on moisture free basis} = \frac{(W_1 - W_2)\ (100 - EE)}{W}$$

Where, W = wt. in g of fat free sample

W_1 = wt. in g of crucible + residue before ashing

W_2 = wt. in g of crucible + ash

EE = Ether extract on moisture free basis

Determination of total Ash

Principle

Total ash (TA) is the inorganic residue which remains after a feed stuff is ignited to carbon free at 550°C in a muffle furnace. In other words, ash is that part of the material which does not disappear at 550°C.

Requirement

1. Analytical balance
2. Asbestos sheet

3. Desiccator
4. Hot air oven
5. Hot plate/gas flame burner
6. Metal tongs
7. Muffle furnace
8. Silica basin/crucibles

Procedure

1. Place silica basin/crucible in hot air oven for drying at 100° ± 1°C for six hours, cool in desiccator and weigh it.
2. Weigh in duplicate 2-10 g of feed sample depending upon the type of feed into a pre-weighed silica basin/crucible.
3. To carbonize the contents, burn and char the organic matter by placing the basin with sample on a low gas flame or hot plate until all smoke and black portions escape out. Do not stir or disturb the material while charring as this will result in a loss of the substance.
4. Keep the crucible in a muffle furnace and raise the temperature upto 550-600°C slowly by setting the regulator and complete the ignition of sample for 2-4 hours at the constant temperature.
5. Remove the silica basin/crucible holding with metal tong from muffle furnace and cool in desiccator and weigh.
6. Since ash is highly hygroscopic, note the lowest weight and report the total ash as per the calculation show below.

Calculation

$$\text{Total ash (per cent) on as such basis} = \frac{100\ (W_2 - W)}{W_1 - W} \quad \text{or} \quad \frac{100 \times \text{wt. of ash}}{\text{Sample wt.}}$$

Where, W = wt. in g of crucible

W_1 = wt. in g of crucible + residue before ignition

W_2 = wt. in g of crucible + residue after ashing

$$\text{Total ash (per cent) on moisture free basis} = \frac{\text{Total ash} \times 100}{\text{DM}}$$

Determination of nitrogen free extract

Principle

Carbohydrates are divided into two groups i.e. crude fibre (CF) and nitrogen free extract (NFE). The NFE comprises the sugars, starch and a large part of the material classed as hemicellulose.

The NFE is not determined by analytical procedures. This is calculated as the figure obtained when the sum of water, ash, protein, fat and crude fibre of a feed is subtracted from 100 since the figure is determined by difference, it includes the cumulative errors of the other determinations and thus it is not an exact value.

Requirement

Following analyzed volumes of a feedstuff are very much essential to derive the nitrogen free extract of the same feedstuff.

Calculation

The nitrogen free extract can be derived from the following formula:

NFE (%) = 100 – (CP%) + EE (%) + CF (%) + TA (%)

If NFE is to be expressed on as fed basis the following formula would be applicable:

NFE% = DM% - CP% - EE% -CF% - TA%

Sample questions

1. What are precautions to be taken in a laboratory?

2. Define various proximate constituents.

3. What is the sampling procedure for feeds?

4. What are the methods of estimation of proximate principles?

5. What is the significance for estimation of moisture in feedstuff?

CHAPTER-3

Grinding and mixing of feed ingredients

Objectives

1. To grind the feeds.
2. To mix the feed ingredients for making compound feeds.

Introduction

For making compound feed, grinding of different feed ingredients is the first step. Then the ingredients are mixed in fixed proportions for different categories of animals.

Grinding

It is a particle size reduction process which is the simplest and least expensive method for preparing feeds for livestock feeding. It is a prerequisite for mixing, pelleting etc. and it varies from fine to coarse. It is usually accompanied by hammer mill which reduces the particle size by means of impact grinding. Medium fine grinding is the best. Very fine grinding makes feeds dusty with lowered palatability resulting in poor animal performance.

Advantages of grinding

- ✓ Increases the particle numbers and thereby increases the surface area for better action of digestive enzymes in the rumen with enhanced digestibility and animal performance.
- ✓ Grinding results in better mixing of feed ingredients facilitating in better extrusion and pelleting.
- ✓ Segregation of particles is avoided.
- ✓ Selective feeding by livestock will be minimize.d or avoided. So wastage in feeding will be minimum.
- ✓ Palatability of ingredients will be improved. Energy loss due to mastication will be decreased. Feed passage time will be decreased. Feed consumption will be increased. But decreased feed passage time reduce the digestibility of fibre in ruminants since residence time in the rumen is less.

Mixing of ingredients

Small quantities of animal feed can be adequately mixed manually using shovels. The ground raw materials should be layered one above one another, and then mixed and turned to form one heap. Mixing of the heap at least 3 to 4 times may produce an acceptable product. Micro-ingredients such as vitamins, minerals, antibiotics, etc. are first mixed with diluents e.g. wheat bran and then it is added to ensure uniform mixing.

For mixing of large quantities of feeds, mechanical mixers such as vertical mixers, horizontal mixers are used for uniform mixing. The most important operation in a feed mill is mixing and this is the single operation that would be required in a plant to define it as a feed mill. The aim of mixing is to disperse the ingredients of a certain formula so that each small unit of the whole has the same proportion of each ingredient as in the original formula..

The addition of various liquids to feeds include molasses, vegetable and animal fats, fish solubles, phosphoric acid, choline chloride, etc. These are added to enhance palatability (e.g. molasses), energy (fats) and other nutrient content of the rations. However, addition of any liquid can complicate feed mixing operations. Special equipment for preheating and spraying of liquid are needed to avoid the agglomerate formation. Agglomerate formation can result in suboptimum microingredient distribution.

Liquids are preheated to reduce their viscosity. Molasses is preheated to 95 to l00°F while fat to 140 to 210°F. When liquids are added to the mixer, they should be sprayed over the entire lenghth of the mixer. Before doing so, allow the dry feed ingredients to mix for short time. This allows the microingredients to be dispersed throughout the moisture. The maximum amount of the molasses that can br successfully employed to the feeds is governed by the viscosity of molasses and by the absorptive quality of ingredients.

Microingredient Premixing

Premixes are formulations of one or more microingredients, such as vitamins, minerals, or drugs mixed with diluent and/ or carrier ingredient. Diluent and carrier should be inert and inactive. Premixes are used to facilitate uniform mixing of the microingredients in the complete feed or concentrate mixture.

Diluent is an edible substance used to mix with and reduce the concentration of nutrients and/or additives to make them more acceptable to animals, safer to use and more capable of being mixed uniformly in feed. The mixing properties of the original ingredients are not drasticaily altered. Carrier is an edible material to which ingredients are added to facilitate uniform incorporation of the latter into feeds. The active principles are absorbed, impregnated or coated into the edible material in such a way as to physically carry the active ingredient. When a carrier is used with a microingredient the mixing properties are

drastically altered.

Microingredients are nutritional adducts or drugs that are added to the feed at very low levels. Dispersion of such low concentrations of active ingredients presents a challenge to the manufacturers of the compound feed. This challenge can be met by the premix-the dilution of an active component with a suitable carrier.

Physical characteristics of microingredients such as particle size, particle shape, specific weight, hygroscopicity, susceptibility to electrostatic charges, adhesiveness of the particles due to physical properties, such as rough surfaces or additions of adhesives such as oils influence mixing them with the other feed ingredients. Microingredients have a very small particle size and high density compared to other feed ingredients. A significant uptake of moisture by a microingredient can seriously hamper its ability to distribute and mix well. A hygroscopic ingredient can affect the chemical stability of any moisture sensitive component. This problem may be dealt with during formulations by complexation or through a coating that acts as a moisture barrier.

Types of mixers

I. Vertical batch mixer

They may be single screw or double screw for elevating the material. However, single screw mixer is popular. These are relatively less expensive and little slower than horizontal mixers. These are not normally used in larger feed mills. It consists of a vertical bin tapering to a point at the bottom. A tube containing a vertical screw conveyor elevates and mixes the material as the mixer is filled. The screw conveyor continuously elevates the product and distributes it over the top of the mixer. Repeated elevation of· the product produces blending. Some mixers use two screw conveyors and few use other elevating devices. Normally screw is driven from the top but it can be driven from the bottom. These units range in capacity from 0.5 to 5 tonnes.

2. Horizontal mixer

This mixer is the most commonly used in larger feed mills. This mixer has right and left hand augers which conveys the material from one end of the mixer to the other while it is tumbled within the mixer. These mixers are equipped with openings at several places along the bottom to aid in more rapid discharge. The mixer shaft is accurately machined and mounted on bearings and is fitted with ribbons/paddles which thoroughly agitate and blend the ingredients to produce homogenous mix. The ribbon assembly /paddle is housed in a tub, the lower half of which is circular. Suitable speed reduction drive is provided to drive the mixer shaft at the designed speed to achieve proper mixing with or

without liquid additives. Other types of mixtures include double paddle horizontal mixers and ribbon blenders

Factors affecting mixing of ingredients

These include physical properties of solids (particle size, shape, density, coefficient of friction, resilience and electrostatic charge) and liquids (density and viscosity). Particle segregation, during or after mixing has been attributed to differences in physical properties of materials and the design of the mixer. A decrease in particle size is necessary to attain a sufficient number of particles for dispersion into each portion of feed. Where very small amount of microingredients are added, the required particle size is very small. The electrostatic properties, roughness of the mixer and cohesiveness are important factors that cause segregation when very small particles are mixed. Mixing time to achieve good distribution increase with very small particles. The rate of mixing is dependent on the properties of the materials being mixed as well as type of equipment used. Differences in the performance of mixing equipment are reduced when the materials have nearly the same particle size and density.

Sample questions

1. What is grinding and its advantages?
2. What are the types of mills used in grinding?
3. What is the process of mixing of feed ingredients at small scale?
5. What are the types of mixing machines?
5. What are the factors affecting mixing of feed ingredients?

CHAPTER-4

Hay and silage making

Objectives:

1. To prepare hay from green fodders.
2. To prepare silage for fodder conservation.

Introduction

The green roughages can be preserved in form or hay or silage which can be used during the period of scarcity. Hay refers to grasses or legumes that are harvested, dried and stored at 85-90% DM. Fresh fodder when packed in a container and allowed to ferment under anaerobic conditions producing volatile fatty acids which preserve the material for a long time with minimum loss of nutrients is called as silage. When hay making is not possible because of high rainfall and less of sun shine available during the period when the green plant material is available in abundance, silage making is a very good option to conserve the green roughages.

A. Hay making

It is the process of preservation of green fodder by drying process. Hay refers to grasses or legumes that are harvested, dried and stored at 85-90% DM. Fodder crop is harvested before maturity (50% flowering stage) when it is still green. The crop is spread over a place in rows and then put on hay racks for further drying under sun. The fodder has to be given turning from time to time and should not be exposed to severe sunshine to avoid decarotinisation. Non-leguminous fodders like oats, jowar and Anjan grass and leguminous fodders like berseem and Lucerne can be converted into hay. Maize and barley are not suitable for hay making. The non-leguminous crops should be harvested after flowering stage and when 50% florescence is there. For leguminous crops, the harvesting should be done just when the flowering starts.

Characteristics of a good hay

- Hay must keep the characteristic green colour of the crop.
- It should be soft and pliable.
- It should be prepared in such a way that there is less loss of leaves due to shattering and maximum amount of green colour is retained by the hay.

- The hay should be free from dust, mould and bad odour.
- The aroma of the finished product should be such that it is relished by the animals.
- It should not have more than 15% of moisture so that it can be safely stored without risk of fermentation and combustion.

Crops suitable for hay making

The fodder crops having soft and pliable stems are more suitable for hay making. Green oats is the best crop for hay making. However, green berseem, lucerne, cowpea, guar, natural grasses, etc. can also be used for hay making if proper care is taken in curing whereby shattering of leaves is avoided. Annual and perennial grasses like *dub,* anjan, etc. can also form good hay. Maize, sorghum, bajra, etc. are more suitable for silage making than for hay making. To prepare hay of thick stemmed crop, it is advantageous to crush the stem or chop the fodder itself, Early cut graminacious crops are most suitable for making good quality hay which are very nutritious and sometimes may be compared with the crop for second cutting.

Fig. 4.1. Oat hay prepared at NDRI, Karnal

Method

The aim of hay making is to reduce the water content of the green crop to a level low enough so that the plant and bacterial enzymes do not act on the plant nutrients. The moisture content in the green crop is reduced to 20% and for bailing and storage it should range between 15-20%. In no case more than 20% of moisture should be allowed in Indian conditions, otherwise, due to fermentation the hay gets very hot and nutrients are lost. Sometimes, there is spontaneous combustion. A practical method of determining the safe limit for hay storage is to twist a wisp of hay in the hands. If the stems are twisted and there is no indication of moisture it can be stored.

In tropical countries like India there is, however, greater prospect of making good quality hay both in the sun as well as on the farm. During the *kharif* season (wet and hot), the crops may be harvested in the early September when the monsoons are at decline and during *rabi* (dry and cold) season the crop may be harvested during February-March for hay making.

For the efficient production of good quality hay, the crop should be harvested early in the morning when the dew has dried. However, some experiments have shown that there is no advantage in delaying the cutting grasses. After cutting, the grasses are left as such for few hours for the curing. After about 4 to 5 hours, if there is a good sunshine, the fodder may be turned upside down with the hay rack. If it is September and October by afternoon, the moisture may come down from 75 to 40%. In the evening, small loose heaps (windows) can be formed with the hay rack and fodder is left. On the next day one or two turnings are given and by afternoon the moisture level will come down to 25%. At this stage it can be baled and kept in baled form or if it is heavy rainfall area it can be stored on tripod stand. The tripod system of hay making has an advantage that if there is rain the water will pass down and there is proper aeration from below which inhibits the fermentation.

Various methods of drying the forages have been tried in India like drying the crops on fencing, wires, roofs tops, tree tops, galvanized tin sheets, tripod stand, etc. Care should be taken to avoid shattering of leaves in leguminous crops like berseem, lucerne, cowpea, etc. For heavy rainfall areas hay curing sheds have been developed where monsoon grasses are dried.

Factors affecting the nutritive value of hay

1. Stage of harvesting

The nutritive value of the fodder goes down as the plant matures. At a very early stage the protein and energy contents of the fodder are very high but the dry matter yield of

the fodder per unit area is very low. At the later stages when the crop is full bloom, the protein value goes down and the digestibility of nutrients is also reduced. The total yield of dry matter is increased. In order to get more nutrients per hectare, the crop should be harvested just at preflowering stage or when about 10% of the crop is in bloom. This is the time when plenty of sunshine is also available for hay making. Under high moisture and temperature fungi and moulds may grow on the hays. Such infested hays are unpalatable and harmful to the farm animals and men. In later case, allergy to the farmer handling the infested hay has been reported. Common salt and fungicides like phosphoric acid have used to check the growth of moulds. Curing of hay under normal sunshine condition does not affect the nutritive value of the hay. However, if the crop is not quickly dried and left in the field unattended, then there are heavy losses.

2. Shattering of leaves

This loss is more common in leguminous crops like berseem, lucerne, cowpea, etc., where the leaves dry earlier than the stems. If drying is prolonged without proper turning, the leaves become brittle and shatter. Sometimes this loss becomes very serious since leaves are richer in proteins, vitamins, minerals, etc. than the stems. This loss can be reduced if the forages are-chaffed before curing them for hay. Leguminous hays should be transported from the field early in the morning so that with dew there is less shattering of leaves.

3. Fermentation

After the crop is harvested, the plant enzymes act on the soluble carbohydrates forming thereby carbon dioxide and water. Therefore, in a normal hay making process some of the nutrients are lost which results in the higher crude fibre content of dry matter of hay as compared to the green fodder analysed before hay making. Although major changes during hay making occur in the carbohydrate fraction but other nutrient like protein is also affected. Proteins are also hydrolysed to amino acids which may be lost if there is a rain on the hay due to leaching. In a normal curing there is a loss of about 5~9% of dry matter.

4. Oxidation

If the green fodder is exposed to the sun for a longer period without proper turnings, nearly all the carotene will be lost. In the green fodder, it is between 150-200 ppm of dry matter and due to bleaching it can be reduced to 5-10 ppm. Rapid drying of the crop on tripod system conserves the maximum amount of carotene. Sunlight has a beneficial effect vitamin D_2 formation.

5. Leaching

During hay making, if heavy rains prolong, severe losses due to leaching occur. Leaching causes loss of protein, NFE, soluble minerals and vitamins. The crude fibre content is increased.

B. Silage making

Silage: It is the green material produced by controlled fermentation of green fodder containing high moisture level. Fresh fodder when packed in a container and allowed to ferment under anaerobic conditions producing volatile fatty acids which preserve the material for a long time with minimum loss of nutrients is called as silage. The process of silage making is called ensiling.

Characteristics of a good silage

Among the physical characteristics, it should have acceptable aroma without mould growth. A good silge is greenish yellow and is highly palatable to the animals. A fermentation loss of 10-15% cent is acceptable. Chemically, its pH value should be between 4-5, in proportion to lactic acid, other volatile substances should be less, ammonia should not comprise more than 10-12% of total nitrogen. Concentration of butyric acid should be less than 0.2 %.

Suitable crops

Soluble carbohydrate rich crops like maize, sorghum, bajra, napier, oat etc. are suitable for ensiling. Cultivated and natural grasses are very good substrate for ensilage. The crops used for the purpose should have about 65%. Legumes may contain 60-65% moisture. The crop should have solid stem so that small amount of air is trapped. For hollow stemmed crops, trampling should be adequate. Stage of harvesting is also an important aspect. For silage, maize should be harvested at dough stage, sorghum and bajra at milk to dough stage and natural grasses at flowering stage. Leguminous crops may also be ensiled with cereal crops in different ratios (2-4: 1).

Method

There could be several methods, however, the principle is same that green crops harvested at 65-75% moisture level can be ensiled or better chopped/chaffed. The mass is packed in silos so that it contains no or vey less air after trampling down using tractor or bullocks. After proper packing, the material is packed/sealed with mud/straw/polythene sheets. The soluble carbohydrates in the fodders are converted mainly to lactate and other

organic acids by lactic acid bacteria. The resulting product is acidic in nature (pH=4.0). At this pH undesirable butyric acid production is inhibited and so also the degradation of proteins to ammonia and amines. This can be achieved by proper compaction of the chaffed fodder. The exclusion of air from silo minimizes the loss of nutrients due to respiration and encourages the growth of lactate producing bacteria, prevents the growth of aerobic organisms producing heat at the expense of nutrients. The silo should be airtight which can be done by providing polythene sheets all around (top, side and bottom). Inoculation with lactic acid bacteria (e.g. *Lactobacillus plantarum*) results in lactic acid production provided that forage contains sufficient amount of soluble carbohydrates. Silage is ready after 4-6 weeks Higher moisture (>70%) should be avoided as it promotes undesirable clostridia. As far as possible, soil contamination should be avoided.

Tower and trench silos can be used for silage making. Silos should have air tight walls having no cracks whether they are above or below ground. If above ground, air may enter through cracks and moulds may grow while below the ground invites rain water and spoilage.

Fig. 4.2. Silage making

Advantages of silage making

- Silage can be prepared from green fodders when weather does not permit hay making.

- Silage can be prepared from plants which have thick stems and normally not suitable for hay making (e.g. sorghum, maize etc.)
- Weeds can be used alongwith major crops for ensiling. The process also destroys weed seeds.
- It is highly palatable to cattle and buffaloes.

Sample questions

1. What is the importance of hay and silage making?

2. What are suitable crops for hay or silage making?

3. What are the characteristics of good hay and silage?

4. How would you prepare hay and silage**?**

CHAPTER-5

Preparation of calf starter

Objectives

To prepare calf starter for better growth of calves.

Introduction

Calf starter is a high quality concentrate mixture fed to the calves provided with limited milk. Feeding of calf starter helps in rumen development so that the calves can utilize fibrous feeds at an early stage.

Preparation of calf starter

The calf starter is a balanced concentrate mixture which is fed to the calves to supplement the nutrients when they are raised on limited milk intake. After proper feeding and management, male calves attain about 60-70 kg kg body weight and female calves 50-60 kg body weight after 90 days of age. By this time rumen fermentation starts functioning and it is not economical to provide them milk or milk replacer. After 90 days, they should be offered high quality concentrate known as calf starter. By this age calves start consuming green fodders also. The calf starter should contain about 22% CP or 18% DCP and 72-75% TDN. Calf starter should be of high quality and should include mineral mixture and vitamins. Calf starter can be fed from the age of 42 days along with milk or skim milk and good growth can be achieved. Milk or milk replacer feeding should be completely stopped after 90 days and calf starter feeding should be started thereafter. Normally a calf can consume 1. 0 kg calf starter each day. The composition of calf starters has been given in the following two Tables.

Table 5.1. Composition of calf starter-1

Ingredient	Protein (%)	Parts (%)	Crude protein (%)	DCP (%)	TDN (%)
Ground maize	9	42	3.78	2.94	33.60
Groundnut cake	40	28	11.20	9.80	21
Fish meal	70	7	4.90	4.55	5.60
Wheat bran	16	20	3.20	2.00	12.00
Mineral mixture	-	3	-	-	-

Table 5.2. Composition of calf starter-2

Ingredient	Protein (%)	Parts (%)	Crude protein (%)	DCP (%)	TDN (%)
Ground maize	9	30	2.70	2.10	24.00
Groundnut cake	30	40	12.00	10.00	30.00
Fish meal	70	7	4.90	4.55	5.60
Rice bran	13	10	1.30	0.80	6.00
Wheat bran	16	10	1.60	1.00	6.00
Mineral mixture	-	3	-	-	-
			22.50	18.45	71.6

Sample questions

1. What is calf starter?
2. Give the composition of calf starters.

CHAPTER-6

Pearson square method for preparation of concentrate mixture

Objective

To prepare concentrate mixture using Pearson square method

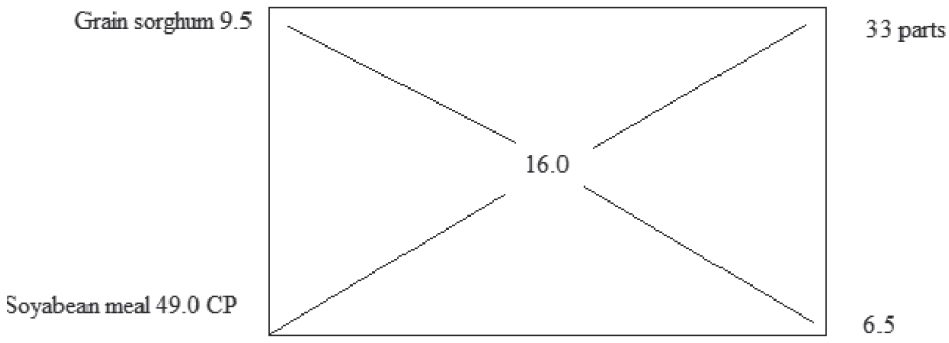
Introduction

For preparation of balanced rations for dairy animals, inclusion of concentrate ingredients is must. Generally diets are first formulated for one nutrient. Then the other nutrients are checked to see whether the feedstuffs used will meet the requirement or whether the feedstuffs used will meet the requirements or whether alternate feeds need to be included in the diet. One mehod is to balance for protein first and then to check energy levels to see whether they are met. Then the ration can be checked for other nutrients like Ca and P.

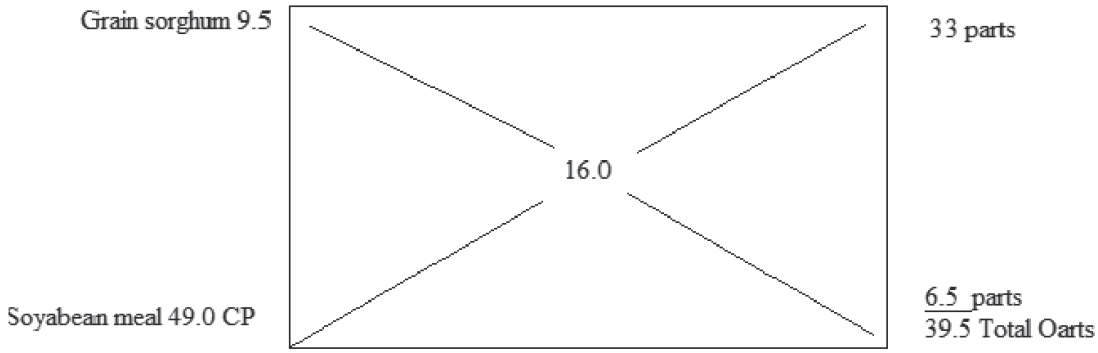
When the number of nutrients specified is small, the diet formulation can be easily carried out using simple calculations. However as the number of nutrient specification or the number of feedstuffs available increases, the formulation becomes tougher. There are 2 methods namely algebric and Pearson square of balancing diets for 1 to 2 nutrients using 2 or more ingredients or using ingredients at fixed level.

Use of Pearson square for concentrate mixture preparation

To use the square, place the desired percentage of protein in the centre of square (for example 16%). Place the percentage of proteins at the left hand corner of the square (9.55 for maize grain) and 495 for soybean meal). Then subtract diagonally, the smaller percentage from the larger percentage and place the answers on the right hand corners of the square (16-9.5=6.5 is placed in the bottom right and 49-16=33 in the top right.



The figures at right hand corners are called parts (33 parts sorghum grain and 6.5 parts soybean meal). The total parts are determined by adding up the individual parts (33+6.5= 39.5 parts. The individual parts are changed to percentages by dividing the individual parts by the total parts (33/39.5= 83.54% for sorghum grain and 6.5%39.5= 16.46% for soybean meal).



Percent sorghum grain in the concentrate mixture: 33/39.5 x 100= 83.54%

Percent soybean meal in the diet: 6.5/39.5 x 100= 16.46%.

Sample question

1. Prepare a concentrate mixture having 18% protein using maize grain (CP=11%) and groundnut cake (CP=45%) by Pearson Square method.

CHAPTER – 7

Preparation of mineral mixture

Objectives:

1. To prepare concentrate mixture as the component to be added in ration for proper growth and milk production at around 2percent.
2. To study the method and percent contribution of each salt in the final mineral mixture.

Introduction

Minerals are inorganic content of the feed, generally supplied through mineral mixture to the animals. Deficiency of minerals not only reduce the production and affect health adversely but also immunity and several other associated complications may develop. So it is necessary to supply 2 percent of mineral mixture in the concentrate mixture for optimum health, production and reproduction. It is observed that minerals are deficient in every corner of India but no uniformity is there for example, more than 50 % of the soil are deficient in Zn but for other minerals deficiency is area specific. So, before preparation of mineral mixture, evaluation of feed, fodder and status in animals is more essential. However, a typical mineral mixture may contain the following components:

Sl no	Component	Percent
1	Di calcium phosphate	54.39
2	Sodium chloride	28.50
3	Chalk powder	10.20
4	Magnesium carbonate	3.00
6	Ferrus sulphate	3.00
7	Copper sulphate	0.50
8	Manganese di- oxide	0.08
9	Cobalt chloride	0.06
10	Potassium iodide	0.01
11	Zinc sulphate	0.26

There are so many salts are used in mineral mixtures and their contribution/ bioavailability is also different, so before preparing any mixtures, it is essential to determine the requirement of the animals, their bioavailability and to which animals these are to be supplemented.

Sample questions

1. Write the importance of mineral mixture in animal body.
2. Why common salt is added to the mineral mixture?

CHAPTER- 8

Computation of ration for different categories of farm animals

Objectives

1. How to compute a ration for farm animals.
2. What percent of roughage and concentrate to be incorporated in the ration of animals.

Introduction

Feeds, fodders for livestock costs around 50-80% depending the type of animals. In ruminants, as these are fed on roughages, feed cost is lesser than non ruminants like pig and poultry. Thus, computation of ration is important to minimize the cost of production and better return to the farmers. For computation of ration information is needed to balance the diet for any animal at any physiological stage regarding the ingredients available, their composition or nutritive value and requirement of the animal. Ration comprises of concentrates, rich in protein and roughages rich in fibre.

Composition of concentrate mixture: A typical concentrate mixture contains about 50% cereals/ energy source may be maize, barley, oats and sorghum grain, 25% vegetable protein source may be mustard cake, groundnut cake, soybean meal and other unconventional oilcakes, 8% animal protein source may be fishmeal, 14% mill by-products may be rice polish, wheat bran, maize gluten etc. and 2% mineral mixture and 1% common salt. The ingredients is to be grind and mix well for feeding of the animals. This mixture may give 18-20% crude protein and 70-75% total digestible nutrients (TDN).

Composition of roughages: Cultivated fodder crops like maize and sorghum, oats are non legumes and have around 6-8% crude protein, 60-65%TDN while legumes like berseem, cowpea and lucerne have 14-18% crude protein, 60-65% TDN on dry matter basis. Hay prepared form oats or sorghum may contain 6-8% CP and 60% TDN while maize silage may contains 6-8% CP and 60%TDN. In addition to these common feeds, there are number of tree leaves and unconventional feeds/ fodders available in different places of India. These are to be judiciously utilized for efficient manner to improve production and economy.

Sample questions

1. What is feed cost for feeding dairy animals?
2. What is typical composition of concentrate mixture?
3. What is crude protein and total digestible nutrients contribution from legume fodders?

CHAPTER-9

Calculation feed fodder requirements using thumb rules methods for various categories of dairy animals

Objectives

Practical feeding of animals under field conditions.

Introduction

Maintenance ration may be defined as the feed required to maintain the essential body processes at their optimum rate without gain, loss in body weight or change in body composition. Under Indian condition, farmers fed their animals very little concentrates unless the animal is in productive stage. Organized farms, progressive farmers and now a days farmers with medium producing animals are also practicing scientific feeding for more returns. Typical thumb rule feeding for maintenance of zebu cattle weighing about 400 kg body weight is straw 4 kg and concentrate mixture 1.1.25 kg while for crossbred cows or buffaloes and pure bred Indian breeds are 4-6 kg straw and 2.0 kg concentrates with little green.

Illustration 1. Feeding of maintenance requirement of crossbred cows weighing 450 kg body weight.

(a) DCP requirement of the animal is around - 0.28 kg an TDN requirement is 3.37 kg.

(b) Straw 5.0 kg (DCP-0%, TDN 42%) will supply DCP- 0 while TDN- 2.10 kg.

(c) Concentrate mixture (DCP-14% and TDN-68%) will supply DCP-0.28kg and TDN-1.36 kg.

So, total DCP supplied to the animal is 0.28 kg and TDN supplied is 3.46 kg which are same to the requirement of the animal.

Illustration 2. Calculate the requirement of a cow weighing 450 kg milk with 4% fat.

Requirement	DCP, kg	TDN, kg	Remark
For maintenance	0.28	3.37	
For production	0.45	3.16	
Total requirement	0.73	6.53	
To be fulfilled through			
Straw, 5.0 kg	0.00	2.10	Straw contains DCP- 0, TDN-42%, green contains- DCP-8% and TDN-60%, concentrate-DCP-14 and TDN-68%.
Green, 3.0 kg (legume + nonlegume)	0.24	1.80	
Concentrate mixture, 4.0 kg	0.56	2.80	
Supplied	0.80	6.70	

Sample questions

1. Calculate the maintenance requirement of a cow weighing 450 kg. The available feeds are concentrate mixture 14% DCP, 68% TDN, Straw and berseem fodder.

CHAPTER – 10

Feeding and watering of animals

Objectives

Feeding of animals, amount of feed and water to be given to the animals.

Introduction

Feeding of the animals is started from morning 6 am to evening 8 pm. During milking it is started with milking in dairy animals with the concentrate mixture and after that watering at around 8 am. Then green and dry fodder and again concentrate during the milking time. Amount of roughage and concentrate varies with stage of the animals and their level of production. Drinking water must be clean, free from pathogenic microbes and algae etc.

Some terms related to feeding of animals

1. **Dry matter:** The feed without moisture sometime referred as total solids. This is the sum of crude protein, ether extract, crude fibre and nitrogen free extract and ash. For example, fresh maize fodder have 75% moisture indicates 10 kg of fresh maize fodder will give (10*75/100 or 2.5 kg dry matter). Concentrate mixture and straws are having 88-92% DM.
2. **Fodder:** green or dry entire above ground part of forages or crops used for animal feeding.
3. **Hay:** the aerial apart of finer stemmed forage crops stored in dry form (moisture comes down to 15-20%). Lucerne and oats fodder are stored in this form due to finer stem and these are to be harvested
4. Legume: Refers to the crops that can fix atmospheric nitrogen into soil through bacteria that live in their roots. Berseem, lucerne, cowpea, clovers etc are the best example and these are to be grown in the land used for rice –wheat cultivation which extract nitrogen from the soil.
5. **Nutrient:** Compounds that lies in feeds/ foods performs specific function in the animal body. For example, fibre in the ruminants or dairy animals have gut filling effect, laxative effect and through fermentation produces volatile fatty acids, that resulting in glucogenic and ketogenic effect. Gluogenic effects causes glucose production and ketogenic effects produces fatty acids and fat in the animal body.
6. Ration and balanced ration: A ration is the feed allowed for a given animal during a

day of 24 hrs. The feed may be given at a time or in portions at intervals. Balanced ration may be defined as the ration that provides all essential nutrients to the animal in such a proportion and amounts that are required for the nourishment of the particular animal for 24 hrs.

7. Desirable characteristics of balanced ration:

   a) Liberal feeding: Animal should be provided plenty with all requirements which are necessary avoiding overfeeding or deficiency, both of which affect the utilization of nutrients in the system for various physiological state.

   b) Individual feeding with balanced ration: Animals should be fed individually instead of herd or flock to fulfill the requirement and minimize the loss and maximize the profit from animal rearing. It will also help to maintain proper physiological functions.

   c) Palatable, good, sound and laxative ration: Bad smell, mouldy, spoiled and poor quality feeds are not taken up by the animals. Feeds should be palatable, sound with good quality without any toxic principles. Feeds/ fodders should be laxative enough otherwise it will incompletely digested and essential nutrients will not be available to the animals. Constipation is often associated with various digestive disorders.

   d) Variety of feeds with vitamins and minerals: For balancing the ration variety of feeds should be incorporated so that deficiency of nutrient in a particular feed may be compensated from the other feedstuffs. At the same time concentrate mixture should contain 2 percent of mineral mixture and 1 percent of common salt to fulfill the mineral mixture as these are important for many vital functions in the body.

   e) Fairly bulky ration with green and dry combination: 2/3rd of the ration must be green and dry combination for optimum production in terms of growth and milk yield. Greens are bulky, easily digestible, laxative and contain enough vitamins and minerals. Green and dry fodder is also essential for dietary fibre and maintaining optimum rumen environment.

   f) Proper mixing, sudden change and economic ration: Sudden changes are often associated with digestive disorders resulting in inappetence causing reduction in milk yield. Green and dry fodder or ingredients used in concentrate mixture are to be mixed properly to avoid any undesirable effect. The ultimate aim is to make animal healthy and profit out of the animal rearing.

Water

Water is the ideal dispersing medium because of its solvent and ionizing powers which

facilitates cell reaction and due to its high specific heat which helps to absorb the heat of these reactions with a minimum rise of temperature. Lean adult body contains about 70 percent of water, though the amount varies from embryo to mature animals. In case of animals, the water content is approximately 95 percent for the embryo shortly after conception, 75-80 percent at birth, 65-72 percent at 5 months and 40-65 percent in mature animal which indicates the importance of water in animal body. It is to be noted that India with less than 3 percent water resources harbouring more than 11 percent animals and more than 16 percent human beings. So, we have to use water in judicious way for better future.

Functions of water

a) By solvent action, it serves as universal medium in which cellular reaction, ionic and other reaction takes place.

b) Lubrication: It acts as lubricant to prevent friction and drying in joints, pleura, conjunctive etc.

c) Hydrolytic action: In this process H^+ and OH^- ions water introduced into bigger molecules to breakdown process.

d) Cell rigidity and elasticity: The body must have a definite form which it can be retain and yet within limits it must be able to change its shape by comprising to some extent to the force applied at any particular point. This is made possible by liquid content of the cell.

e) Transport: It acts as a vehicle for transporting absorbed and reabsorbed of various food materials and excretory products to the definite organ.

f) Heat regulation: As the specific heat of water is high, it is important in heat regulation of body by conduction and distribution, heat loss through urine, feces and respiration as well as sweating.

g) Refractive medium: The aquous humor helps to keep up the shape and tension of the eye ball and acts as the refractive medium of light.

Note: For feeding and watering animals one should stay at any farm/ herd for at least 72 h or 3 days and more for practical purposes.

Sample questions

1 What is balanced ration? What is the importance of forages in dairy animals?

2 Write 3 important desirable characteristics of balanced ration.

3 Write down the main functions of water in animal body.

CHAPTER- 11

Visit to animal nutrition laboratory and feed mill

Objectives

1. To observe the animal nutrition lab., its equipments and appliances, common chemicals used.
2. To observe and operate the feed mill and prepare compound feeds for animals.

Introduction

A typical animal nutrition laboratory have the following instruments and appliances

1. Hot air oven- For estimation of moisture of feeds and fodders.
2. Kjeldahl digestion and distillation apparatus- For estimation of nitrogen.
3. Muffle furnace- for estimation of organic matter and total ash.
4. Soxhlet apparatus- For estimation of crude fat/ ether extract.
5. Hot plate- for heating and churning before ashing.
6. Electronic balance- for accurate weighing of minute quantity of samples.
7. Suction pump- For fibre estimation.
8. Digital pH meter
9. Spectrophotometer
10. Gas liquid chromatography
11. High performance liquid chromatography
12. Atomic absorption spectrophotometer
13. Lab centrifuge and ultra centrifuge
14. Bomb calorimeter
15. Microscope

A typical animal nutrition laboratory have the following glassware and plasticwares

1. Burettes- 10,25 and 50 ml
2. Pipettes- graduated-1,2,5,25 ml and bulb-1,5,25,50 ml.

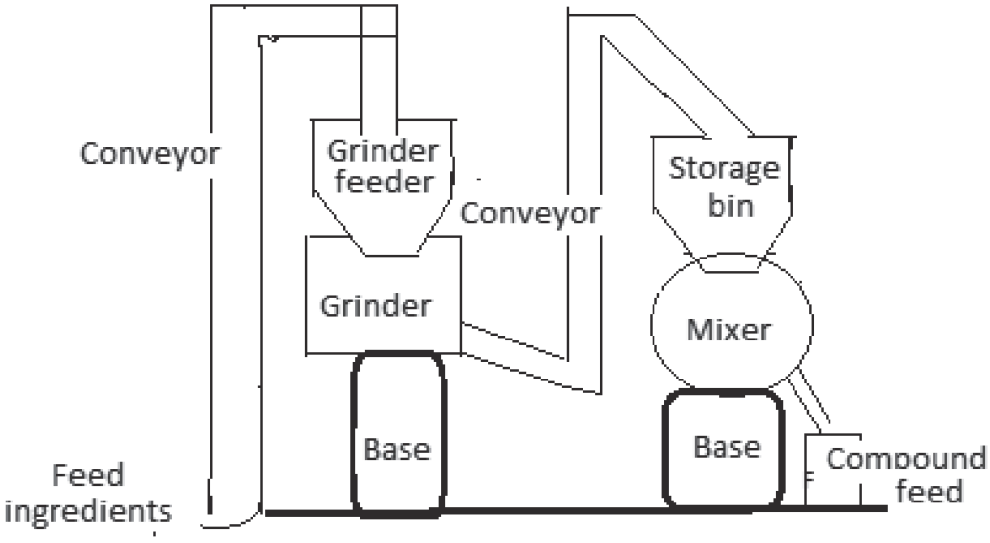
3. Funnels of different size
4. Kjeldahl flask-250,500 and 750 ml
5. Beaker- with and without spout-100, 250, 500 and 1000ml.
6. Round and flat bottom flask
7. Gooch crucible
8. Sintered glass crucible
9. Volumetric flask
10. Graduated cylinders
11. Desiccators
12. Spatula
13. Heating mantle

A typical animal nutrition laboratory may have the following common chemicals

1. Sulphuric acid
2. Hydrochloric acid
3. Nitric acid
4. Sodium hydroxide pellets
5. Sodium sulphate
6. Copper sulphate
7. Potassium dichromate
8. Ammonium molybdate
9. Potassium permanganate
10. Ammonium oxalate
11. Petroleum ether
12. Boric acid
13. Methyl orange, methyl red, bomocresolgreen, phenophthlin indicators

A typical animal nutrition laboratory, in addition to above mentioned equipments, chemicals and glasswares, an animal shed for experimentation and storage space for feeding and watering materials and others should be there.

Compound feed and pellet prepared in feed mill. One can visit the mill for practical knowledge and how it is prepared. Raw materials like cereals, oilseed cakes, mill by products like bran and polish, mineral mixtures is procured and ground initially in grinder and then these are in proper proportion mixed in mixer for compound feed preparation. Simple diagram is shown below for basic grinding and mixing and how these are collected the final product i.e., compound feed.



Sample questions

1. Write the importance of grinder, conveyor and mixer in the feed mill?
2. Name some common chemicals used in lab?
3. What is Kjeldahl digestion and distillation apparatus?
4. What is the use of Soxhlet apparatus in animal nutrition?

CHAPTER - 12

Drawing and labeling of male and female reproductive organs

A. Male reproductive organs

Objectives

a) To learn different parts of male reproductive system

b) To understand the functional significance of different parts of the system

Introduction

Good reproductive performance of a bull is necessary to obtain a high conception rates in natural service or artificial breeding. A bull must be fertile, capable and willing to mate a large number of cows during a short breeding season for optimum production. A basic knowledge of the reproductive tract is beneficial for improved management. An understanding of the bull's reproductive system will also help in better understanding of breeding soundness examinations, reproductive problems and breeding impairments.

Points to remember

1. The testicle is located outside the body cavity in the scrotum and has two vital functions: producing the spermatozoa and male hormone (testosterone).
2. The scrotum provides physical protection to the testicle and helps in regulation the temperature for optimum spermatozoa development.
3. The epididymis is a compact, flat, elongated structure closely attached to one side of the testicle. It is divided into three regions, the head, body and tail.
4. The vas deferens, also known as ductus deferens, emerges from the tail of the epididymis as a straight tubule and passes as part of the spermatic cord through the inguinal ring into the body cavity.
5. The two vas deferens eventually unite into a single tube, the urethra, which is the channel passing through the penis. The urethra in the male serves as a common passageway for semen from the reproductive tract and urine from the urinary tract.
6. The seminal vesicles consist of two lobes about 4 to 5 inches long, each connected to the urethra by a duct.

7. The prostate gland is located at the neck of the urinary bladder where it empties into the urethra. The prostate is relatively small in the bull, as compared to other species, and does not produce a very large volume secretion.

8. The third accessory gland, the Cowper's glands, is small, firm glands located on either side of the urethra. The clear secretion that often drips from the penis during sexual excitement prior to service is largely produced by these glands and serves to flush and cleanse the urethra of any urine residue that may be harmful to spermatozoa.

9. The penis is the organ of copulation. Strong retractor muscles hold the penis in the "S" shaped configuration.

10. The penis is protected in a sheath called prepuce. Indian bulls (like Sahiwal) have pendulous sheath.

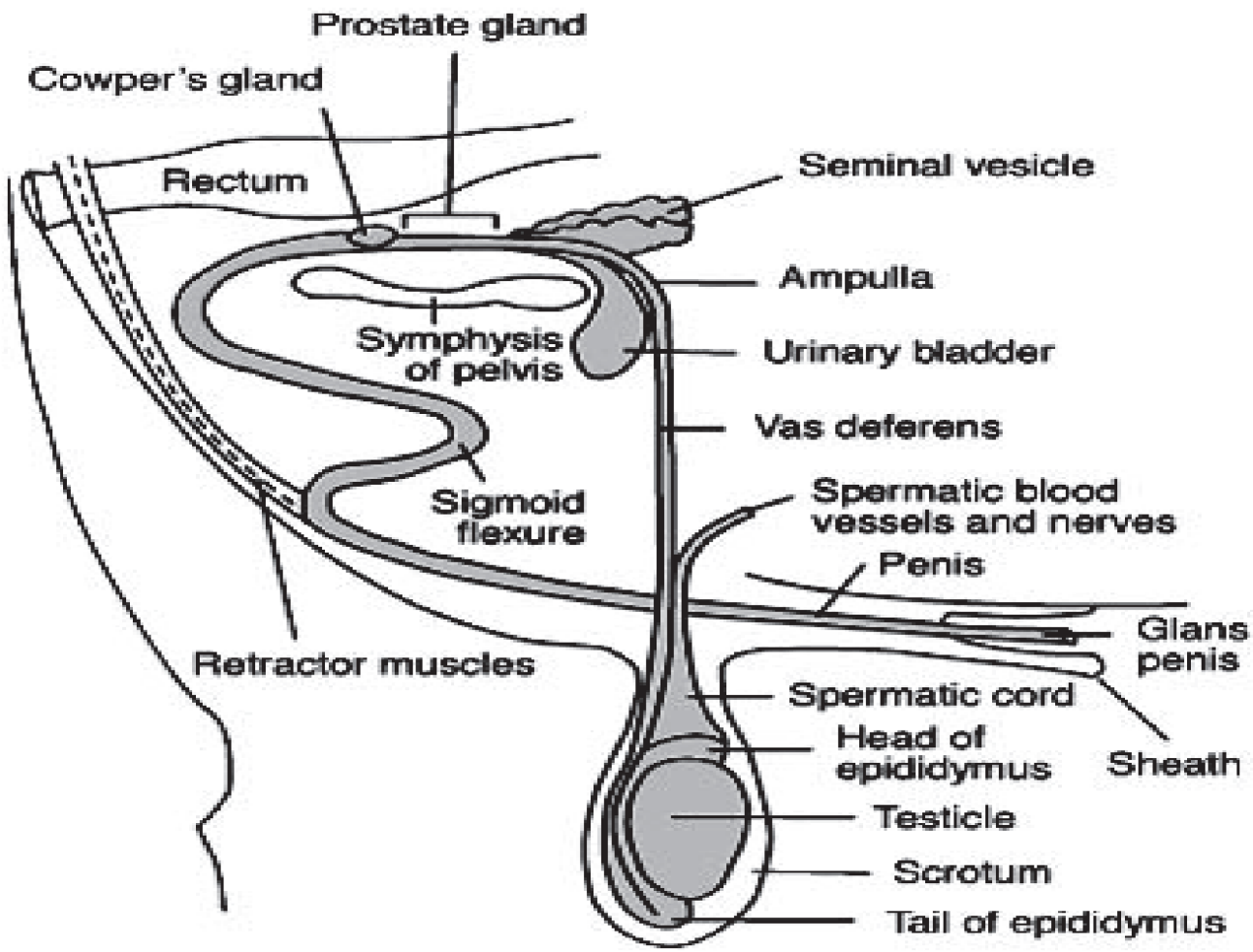
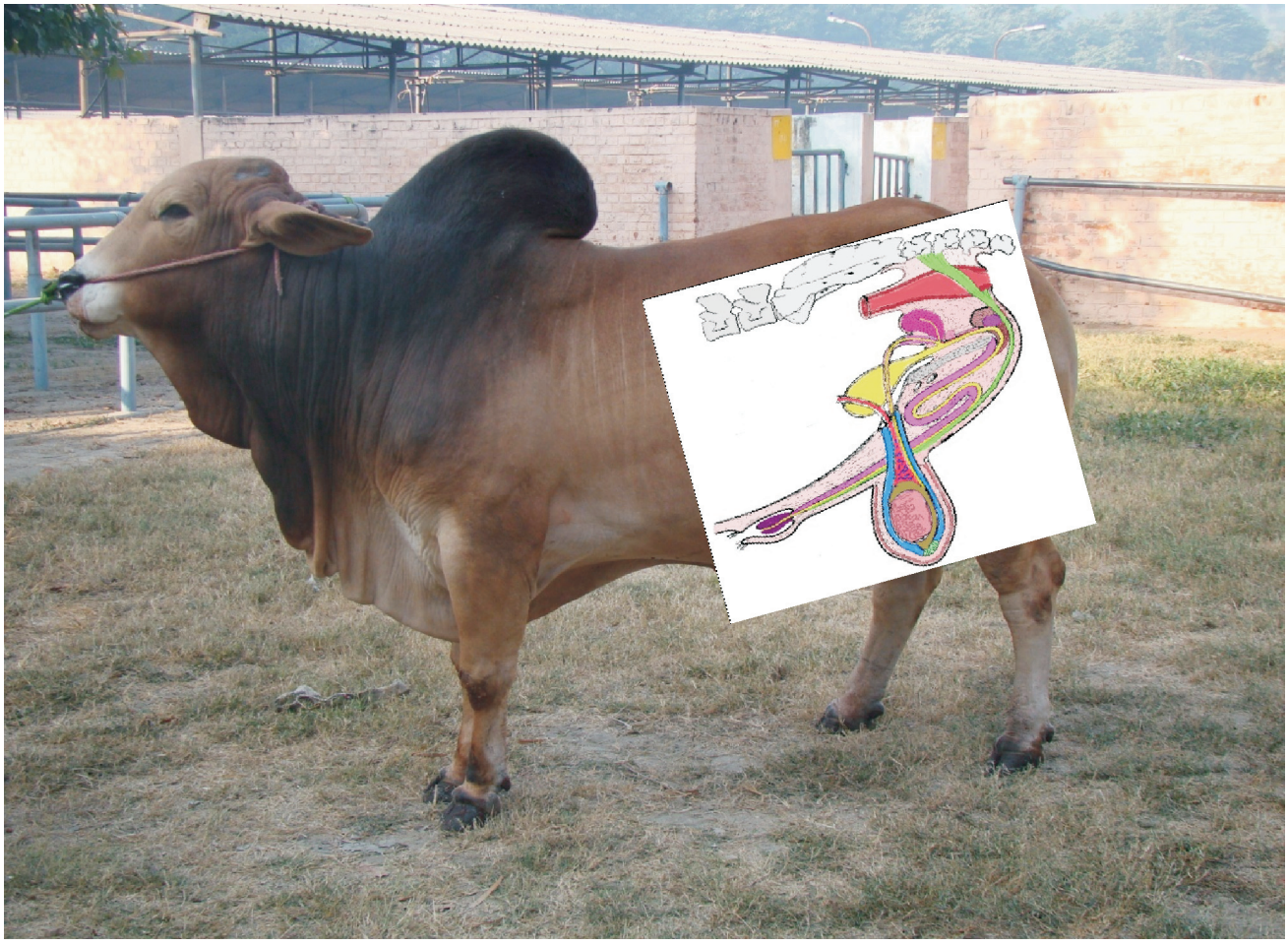


Fig. 12.1 Parts of bull reproductive tract

Sample question:

Identify different organs in the following bull photograph



B. Female reproductive organs

Objectives

a) To study different parts of female reproductive system.

b) To understand the functional significance of different parts of the system.

Introduction

The ability of a cow to successfully mate, conceive, give birth to and raise a healthy calf each year is essential to economical production. A good understanding of anatomy and physiology of both the male and female is helpful in successfully managing reproduction. Thorough knowledge about the anatomy of reproductive organs is primary requisite to understand the reproduction physiology. Unless one know the normal anatomy and

physiology of female reproductive organs, it would not be possible to identify reproductive problems. Also this is essentially required for carrying out artificial insemination in cows.

Points to remember

1. The ovaries are considered the primary reproductive organs in the female. They are primary because they produce the female gamete (the ovum) and the female sex hormones (estrogens and progesterone). The ovary of the cow is almond-shaped.
2. Unlike testes which are located outside the body the ovaries are located inside the body.
3. The oviducts (also called fallopian tubes) are a pair of convoluted tubes extending from near the ovaries to and becoming continuous with the tips of the uterine horns. It is divided into four regions, the isthmus, ampulla, infundibulum and fimbria.

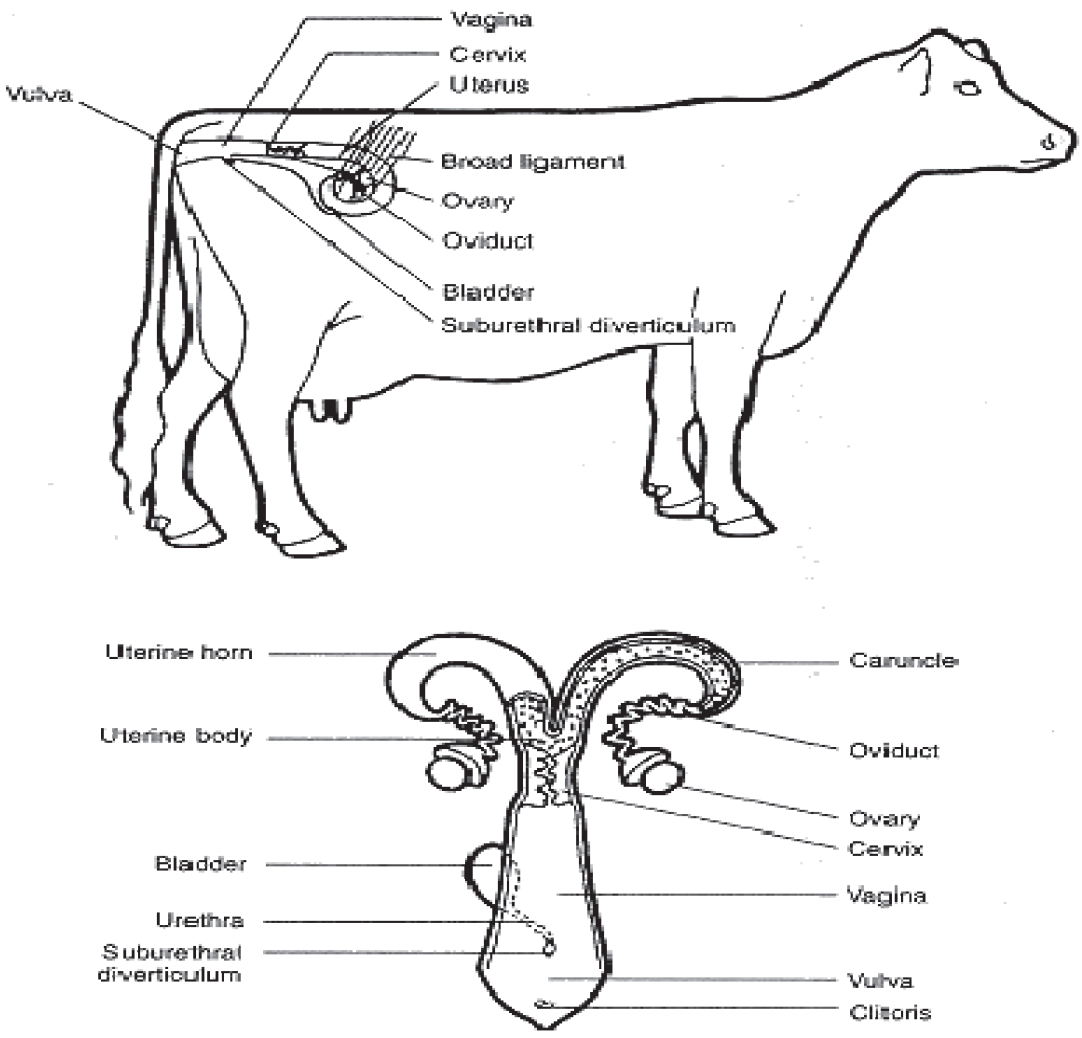


Fig. 12.3. Parts of cow reproductive tract

4. The uterus extends from the uterotubal junctions to the cervix. The body of the uterus of the cow is short and poorly developed, while the uterine horns are relatively long and well developed. The fertilized embryo moves from the oviduct into the uterine horn, where fetal and maternal membrane development begins.

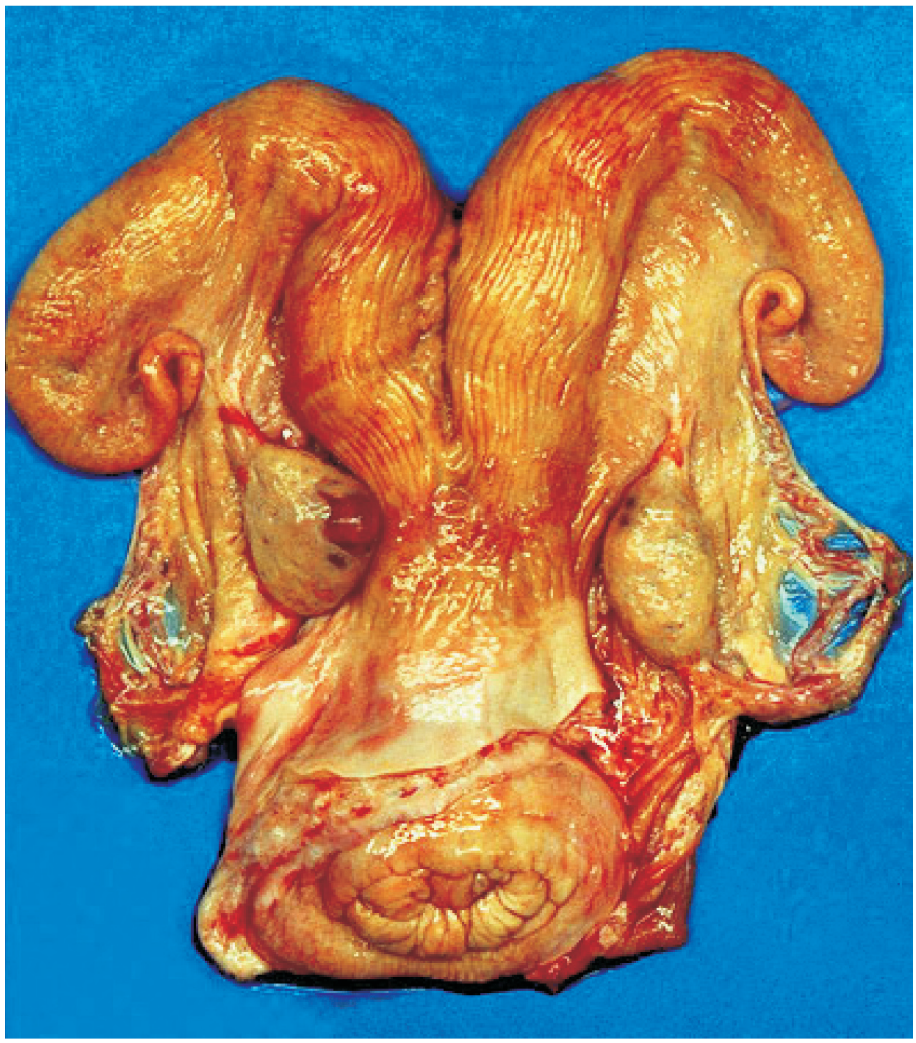
5. The cervix is thick-walled and inelastic, the anterior end being continuous with the body of the uterus while the posterior end protrudes into the vagina.

6. The vagina is tubular in shape, thin-walled and quite elastic. The length of the vagina ranges from 25 to 30 cm in the cow.

7. The vulva, or external genitalia, consist of the vestibule with related parts and the labia. The vestibule is that portion of the female reproductive system that is common to both the reproductive and urinary systems.

Sample question

Identify different parts of cow reproductive tract and label them neatly



CHAPTER – 13

Demonstration of semen collection and evaluation

Objectives

a) To learn semen collection procedures.

b) To understand the semen analysis.

Introduction

The inspection and handling of semen is considered a key and essential step for assessing fertility and the successful use of semen. For use in artificial insemination, there are some pre-requisites that the semen should pass some evaluation criteria. The ideal semen analysis would be simple and effective, allowing the breeding capacity of a particular ejaculate to be predicted. A fertile ejaculate must meet certain semen parameter quality standards, such as progressive motility, normal morphology, active energy metabolism, structural integrity and functionality of the membrane, penetration capacity and optimum transfer of genetic material.

Points to remember

1. Semen is collected by several methods; the most common is the use of an artificial vagina.
2. After the bull has mounted on a dummy, his penis is diverted into the artificial vagina and once the bull ejaculates the semen in the collection tube is immediately transferred to the semen analysis laboratory.
3. General examination of semen includes volume, colour, odour and appearance.
4. Routine microscopic examination includes estimation of mass activity, individual motility, viability, acrosomal integrity and membrane integrity.
5. Several advanced techniques using fluorescent dyes are available nowadays.
6. Using Computer assisted semen analyzer (CASA), one can measure several motility parameters, which cannot be done by normal microscopy.

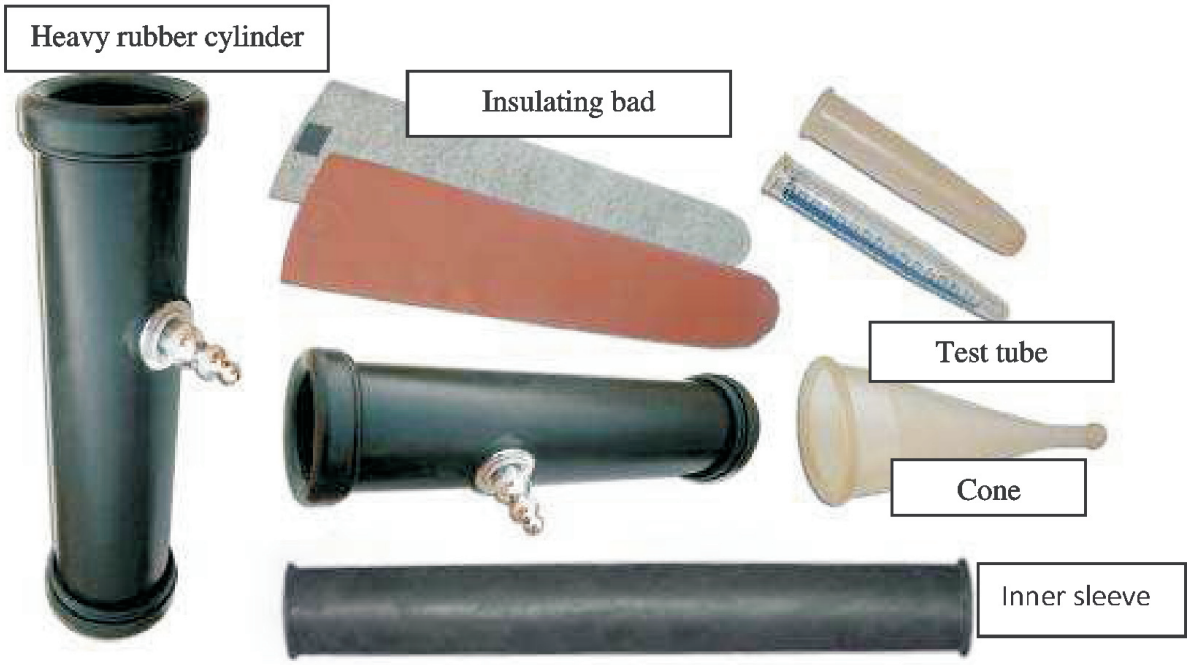


Fig. 13.1. Giemsa stating method for assessment of acrosome integrity

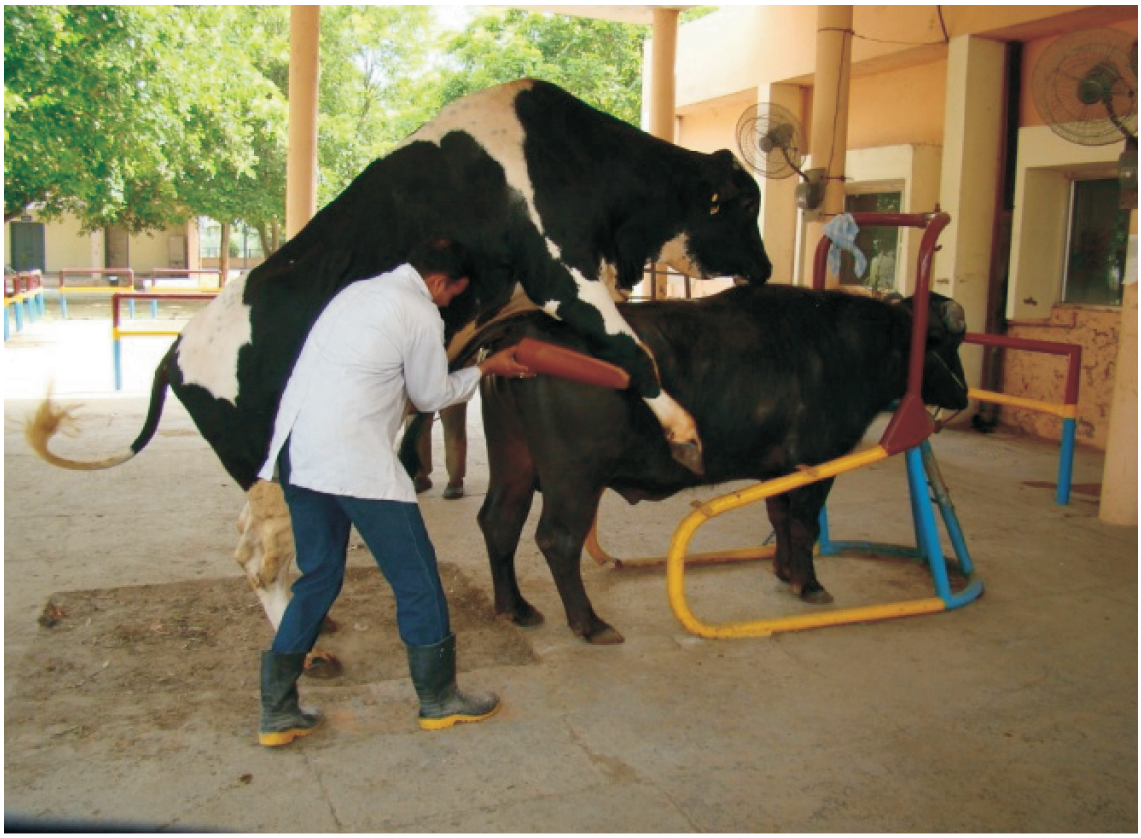


Fig. 13.2. Figure: Semen collection from bulls using artificial vagina

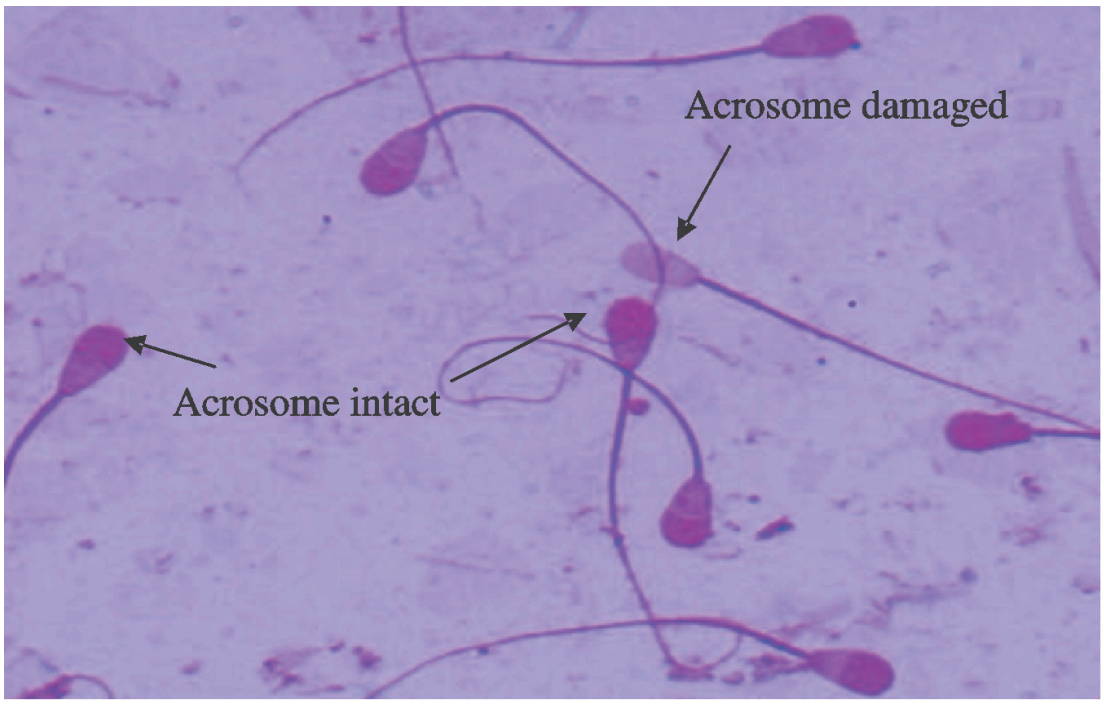


Fig. 13.3. Giemsa stating method for assessment of acrosome integrity

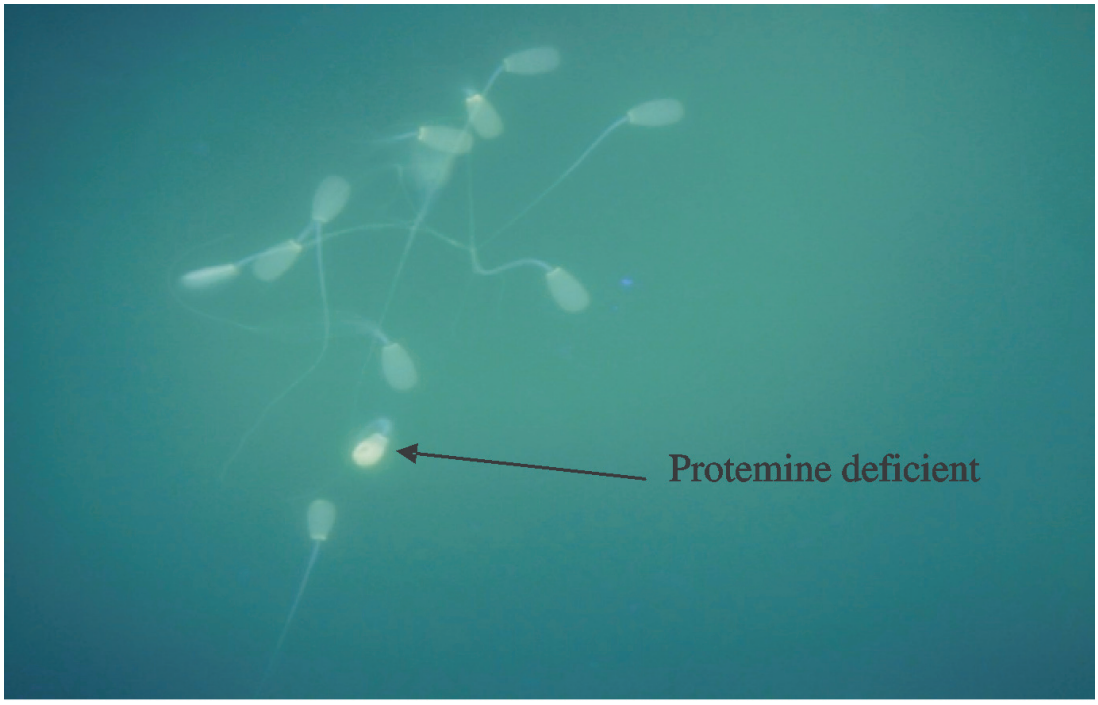


Fig. 13.4. Chromatin integrity assessment using fluorescent staining

Sample questions

1. Write the different parts of artificial vagina.

CHAPTER - 14

Detection of estrus/heat through visual examination

Objectives

To learn about visual method of estrus detection.

Introduction

Effective heat detection is often the most limiting factor in an artificial insemination program. Heat," or estrus, is the period of time that occurs, on the average, every three weeks (18–24 days) in sexually mature, non-pregnant female cattle. They are receptive to mounting or riding actively by a bull or other cows. As an egg develops in the cow's ovary, the sex hormone estrogen (produced by the ovary) causes changes to the animal's reproductive, circulatory, and nervous system. Physical mounting, or "standing heat," occurs within the first 12–18 hours after the onset of heat. Several methods of heat detection can be implemented. Some involve using heat detection aids. Out of all the heat detection method, visual observation is most commonly used method.

Points to remember

1. Visual observation is a commonly used method of heat detection. It involves a trained observer's recognizing and recording signs of heat.

2. Observable signs of heat include mounting or attempting to mount other cattle, standing to be mounted by other cattle, smelling other females, trailing other females, bellowing, depressed appetite, nervous and excitable behaviour, mud on hindquarters and sides of cattle, roughed up tail hair, vulva swelling and reddening, clear vaginal mucous discharge, and mucous smeared on rump.

3. The surest sign of heat is when a cow or heifer allows other cattle to mount her while she remains standing. This is called standing heat. Cattle may be willing to

mount others but may not stand to be mounted when outside of standing heat. This usually indicates she is either coming into or going out of standing heat.

4. This method requires observation of cattle at least twice daily, typically early in the morning and late in the evening for best results. More frequent observation of cattle for heat improves accurate detection of heat. Nearly 20 percent more cattle will be observed in heat when checked four times per day versus checking twice daily.

5. Check cattle as often as practical. Each observation period must be sufficiently long, usually at least 30 minutes, to be effective.

6. Standing heat can occur any time in a 24-hour period. However, the most likely time for a cow or heifer to show heat signs is at night.

7. The season of the year can influence this, with more cows showing heat at night in hot weather and more showing heat during the day in cold weather. Housing conditions can also have an effect on the distribution of heat during a 24- hour period. Hot weather, high production, crowded conditions, and high stress environments may reduce mounting activity.

Estrus detection in buffaloes

Estrus behaviour in buffalo is less pronounced than in cows. Therefore it is difficult to detect. Acceptance of male is considered as the most reliable estrus signs in buffalo. Some of following the sign they may show during estrus.

1. Restlessness, bellowing, valver lips appear moist, red, swollen, turgid and stands prominently.

2. Wrinkles on the vulva disappear, clear, shiny, stringy odourless mucous discharge sometimes extending from vulva to feet.

3. Inappetance, nervousness, riding on other buffaloes or allow other buffaloes to mount on her.

4. Reduction in milk yield, standing alone with frequent micturition with raised tail and crutching the back and lumber region etc.

Fig. 14.1. Mucus discharge from vulva is a certain sign of estrus

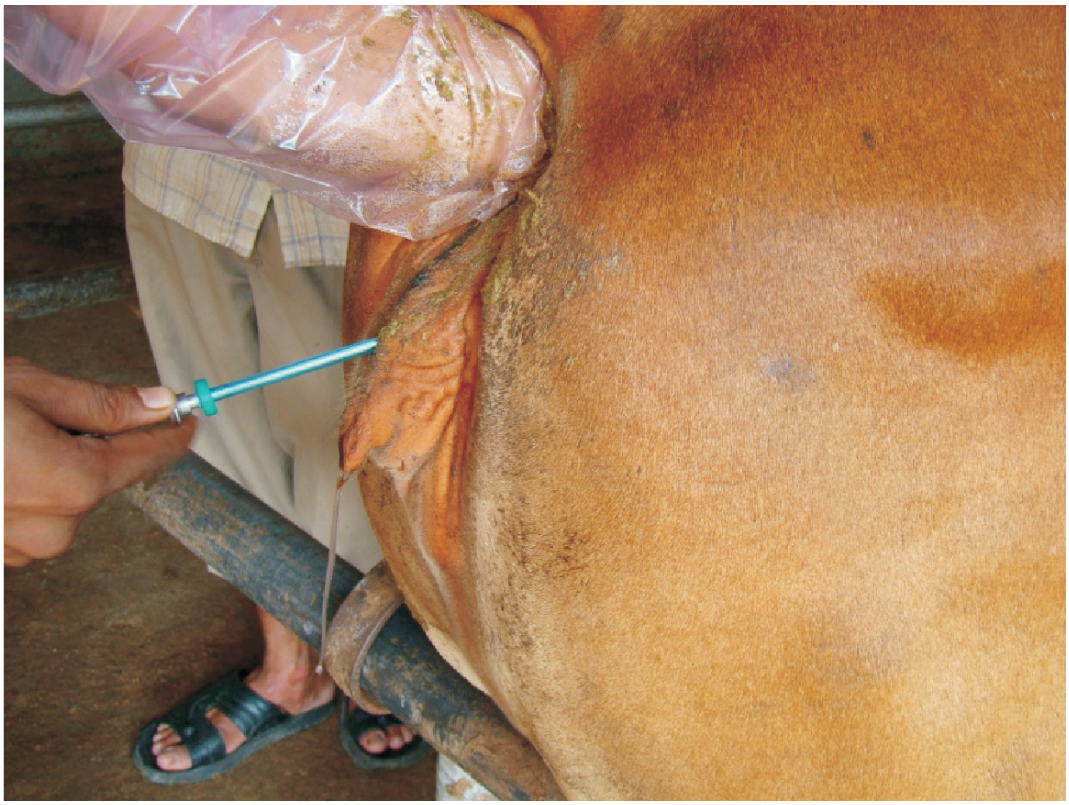


Fig. 14.2. Standing to be mounted by others is indication of estrus in cows

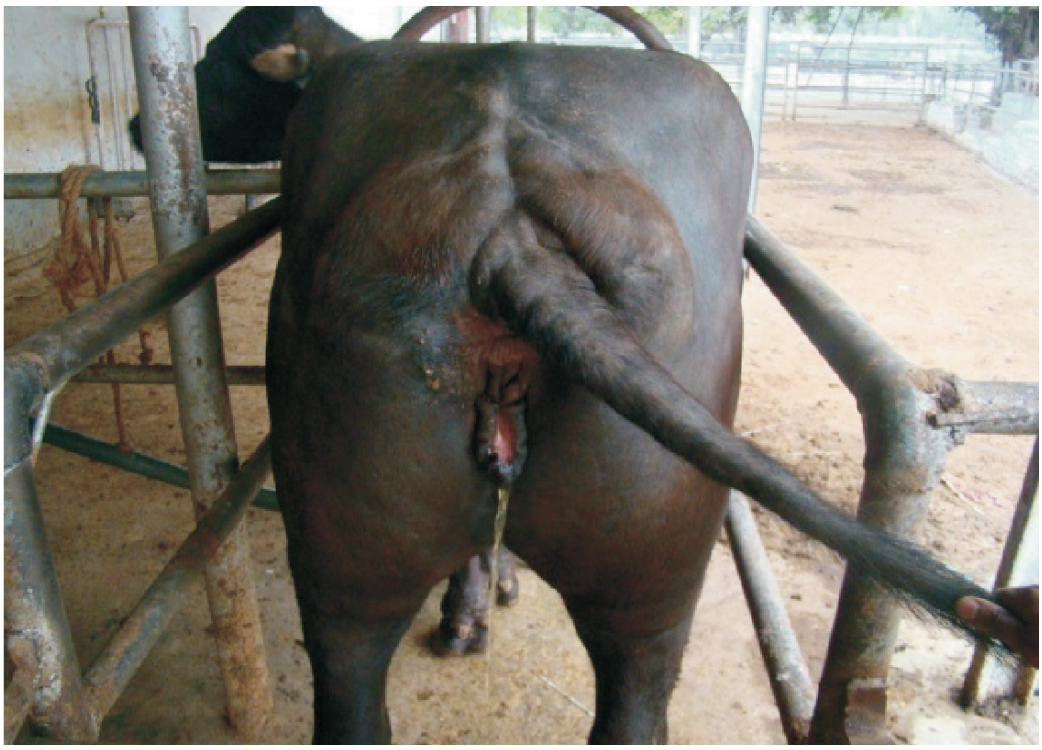


Fig. 14.3. Standing to be mounted by the teaser bull indicates estrus in buffaloes

Fig. 14.4. Frequent urination and reddening of vulval mucus membrane during estrus in buffaloes

Sample questions

1. Write the different symptoms of estrus in cattle and buffaloes.
2. What do you mean by standing heat?

CHAPTER - 15

Visit to Veterinary Hospital/AI Centre for Demonstration of Artificial Insemination

Objectives

a) To know the functioning of Veterinary hospital.

b) To get first hand exposure on AI.

Introduction

Veterinary medicine is the branch of science that deals with the prevention, diagnosis and treatment of disease, disorder and injury in animals. Veterinary doctors are involved in artificial insemination, treatment of ailing animals and advising farmers for better dairy animal production.

Most of the veterinary hospitals have facilities for minor diagnostic procedures. Visit a nearby veterinary hospital and acquaint yourself with the routine activities of the hospital. Note down the instruments available in the hospital and know about the purpose for which they are used.

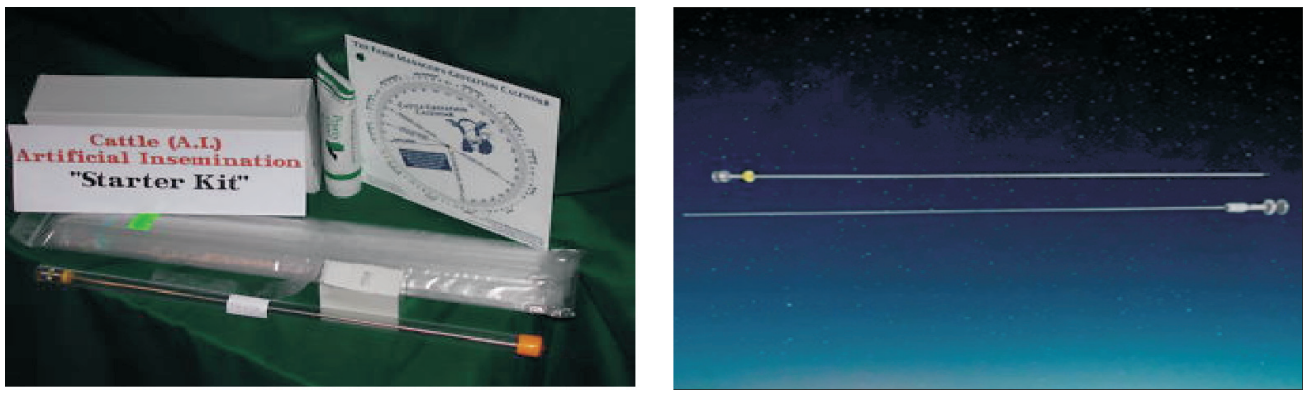


Fig. 15.1. Gun and plastic sheaths

Fig. 15.2. Semen straw holding forceps

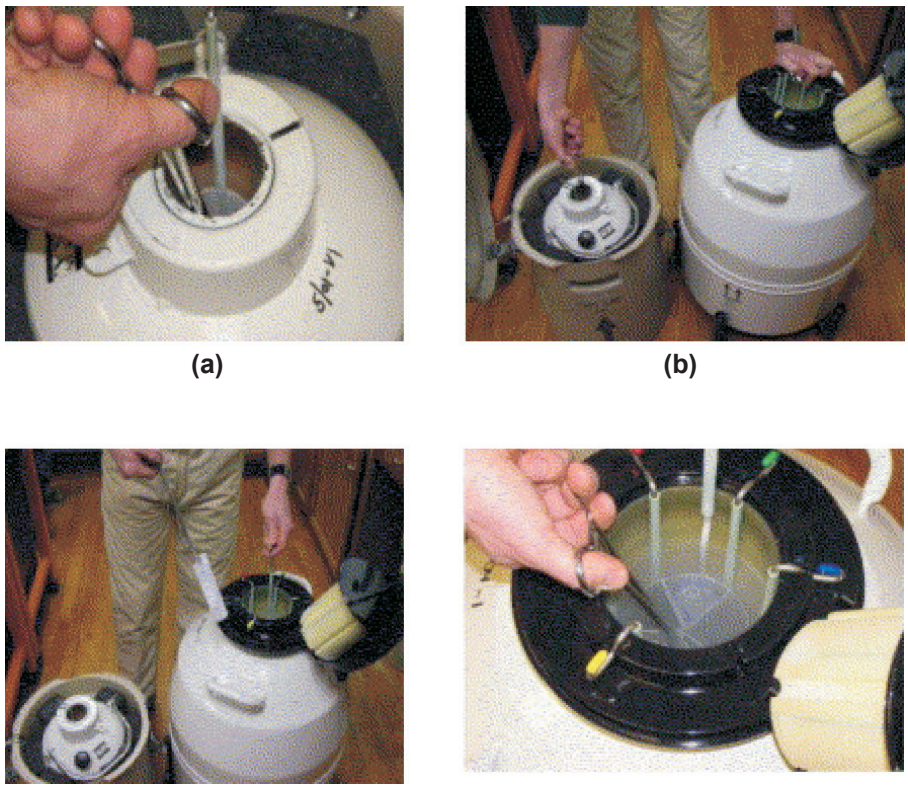


Fig 15.3. Steps for taking out straw for thawing and transportation

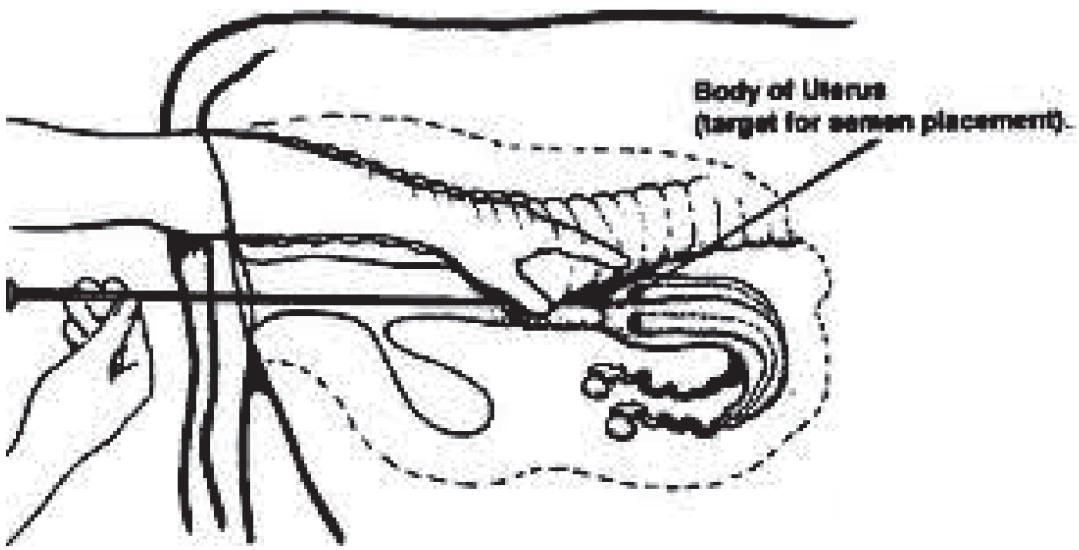


Fig 15.4. A.I in cattle

Sample questions:

1. What did you learn about A.I after visiting the A.I center or hospital?

EXERCISE NO. 16

Different equipments used in artificial insemination

Learning objectives

To know about the equipments used in artificial insemination

Introduction

Knowledge about different equipments used in artificial insemination of cow and buffaloes is important for successful AI. It is necessary to store all the insemination equipment in a clean plastic or stainless steel box. Keep this box closed when it is not being used. Clean all equipment before returning it to the box. Always maintain sterility of the plastic sheaths used to cover the straw gun.

Equipment used in A.I.

1. Liquid nitrogen container (s) with frozen semen.
2. Dip stick for measuring the level of liquid nitrogen.
3. A.I. gun appropriate to the type of frozen semen straw (medium/ mini)
4. Plastic sheaths in sufficient number appropriate to the type of frozen semen straw in intact polythene bag.
5. Semen straw holding forceps.
6. Thawing box.
7. Clean absorbent cotton/ clean cloth for absorbing moisture from thawed semen straw.
8. Clean and sharp scissors for cutting the sealed end of the straw.
9. A clean and hygienic tray for carrying A.I. gun, sheaths, scissors and straw holding forceps etc.
10. Soap and clean towel
11. Centigrade thermometer for checking temperature of the taw bath.
12. Enamelled jug and bucket for water.
13. Register/Cards for record regarding artificial insemination done

Liquid nitrogen container, its construction and precautions in handling

Liquid nitrogen container is double layered vessel. The inner chamber is suspended in the outer chamber through neck tube which is non-metal and a bad conductor of heat. This structure (neck tube)prevents transfer of heat from outside to the inner chamber and thus rapid evaporation of the liquid nitrogen is prevented. The neck tube is a weaker structure compared to metallic parts. Sudden moves and jerks vibrate the inner chamber. Thus side to side movement of the inner chamber must considerable stress on the neck tube which is non-metal and delicate and very often leads to mechanical damage. The wall of the inner chamber is coated with high quality insulating material is also filled in between the outer and inner chambers. Vacuum is created in between the inner and theouter chambers. In the absence of the vacuum the liquid nitrogen would boil and there would be rapid loss of liquid nitrogen from the inner chamber. A highly visible frost at the top of the liquid nitrogen container is indicative of rapid evaporation of the liquid nitrogen.

Precautions

1. Liquid nitrogen should be kept in a cold place. Exposure to direct sun light and hot air should be avoided.
2. The room for storing liquid nitrogen containers (filled with liquid nitrogen) should be well ventilated.
3. Avoid direct contact of liquid nitrogen containers with hard floor. Use rubber/jute mats.
4. Avoid moisture on floor.
5. Avoid injuries, drilling, puncturing and scrapping.
6. Do not play with vacuum knob.
7. Never roll the liquid nitrogen containers.
8. Use trolley in the transportation of the liquid nitrogen containers.
9. Do not put liquid nitrogen container one over other.
10. Fill the liquid nitrogen slowly
11. Make regular checks of the liquid nitrogen in the container.
12. Do not put undesired material in the liquid nitrogen containers.

Dip stick for measuring the level of liquid nitrogen in the container

Checks regarding the level of liquid nitrogen in the cryocan are made by dipping a ruler in the cryocan. The dip stick should strike the bottom of the cryocan and should remain in the tank for about 10 seconds. Once the dip stick is removed from the liquid nitrogen container and is waved in air, frost is formed on it, in just few seconds. The frost indicates the level of the liquid nitrogen in the liquid nitrogen container. Black coloured dip stick is preferred, since it provides a good contrast between white frost and black coloured dip stick.

Precaution

1. Unnecessary and frequent measuring of the liquid nitrogen level should be avoided. It leads to unnecessary evaporation of liquid nitrogen.
2. Dip stick should not be kept loose, otherwise it may break. It should be hanged through wall.

A.I. Gun

The A.I. gun should match the straw of frozen semen and should always be kept clean and hygienic.

Precaution

1. Care should be taken to avoid bending of A.I. gun and piston wire.
2. It should be clean and hygienic.
3. For further protection, A.I. gun may be kept in plastic/perpex container.

Plastic sheaths

Plastic sheaths should match the A.I. gun and the semen straw and should never be kept loose. The sheaths should always remain in a polythene packet. The packet of the sheaths should be given a small cut towards the side of the broad end of the sheaths to take out sheaths for use.

Calculation & Inference: **Date:**

Signature of the Teacher

CHAPTER - 17

Care, sterilization, storage and upkeep of ai equipments

Objectives

a) To learn the procedures and methods used for sterilization and upkeep of AI equipments.

Introduction

Knowledge about different procedures for cleaning and sterilization of equipments used in artificial insemination is very important for achieving high conception rates in bovine. It is necessary to store all the insemination equipment in a clean container.

Cleaning

Immediately after use of all A.I equipments should be washed thoroughly with water. Semen/ egg yolk adhered in the capillaries of A.I catheter or other glass wares get dry after a mean time then it is difficult to clean the glass wares. After doing A.I, catheters should be washed in running tap water to clean the remaining semen in the catheter. Glass wares may then be put in chromic acid solution for overnight dip to remove cloudiness in the glass wares. Application of corrosive substances should be avoided on substances like rubber-wares, it reduces the life span of rubber wares. All the equipments then washed with lukewarm soap solution using brush to make the articles grease free. Finally all the equipments are then washed with running tap water and put inverted for air dry.

Artificial vagina should be thoroughly washed using lukewarm detergent solution and brush. No need of separating the inner rubber lining from hard rubber cylinder while washing artificial vagina.

Sterilization

Sterilization is either physical or chemical treatment to eliminate microbes from the equipments. Unsterilized equipments may be the source of infection to female genital tract. Micro-organisms present in the semen reduce the life span of semen in the female reproductive tract. Sterilization of equipments should be done at all stages (Buffers, Semen dilutors, Semen storage & A.I) without negligence.

Dry heat sterilization

Generally preferred for glass wares & metallic wares. Dry heat sterilization process is easy & rapid and all the organisms are susceptible to dry heat sterilization. The pathogenic bacteria, viruses and fungi are killed within few minutes at 50-70ÚC and the spores of various pathogens are killed at 100ÚC. It is a common practice to sterilize all glassware and metallic wares in hot air oven at 180-200ÚC for 1 hour.

Autoclaving

Sterilization by autoclaving is a very popular method. The rapid action of sterilization by autoclaving is mainly due to latent heat of water vapor (540cal/gm).All rubber articles and artificial vagina may be autoclaved at 10 lb (4kg) pressure at 115.6ÚC for 20 minutes. Avoid high pressure, it would spoil and change the shape of such articles. Other articles including buffer solutions and Vaseline may be autoclaved at 17 lb (7kg) pressure at 121 ÚC for 15-20 minutes. Autoclaving is not suitable for solutions containing sugars, because it destroys sugars. Sterilized articles must be stored at air tight cabinets and buffer solutions after autoclaving, should be cooled down to room temperature and should be stored in refrigerator for use.

Ultraviolet radiation

Ultra-violet adsorption of bacteria is chiefly by purines and pyrimidines of nucleic acids and less to aromatic rings of proteins. Absorption of ultra-violet radiation causes lethal effect to nucleic acids & proteins. Semen processing lab should have low pressure mercury vapor lambs for sterilization purpose.

Gaseous sterilization (ethylene oxide)

Ethylene oxide is an effective sterilizing agent at lower temperature with good penetrating power under less desirable effects. It is used to sterilize heat labile & moisture sensitive objects like rubber, plastic wares & electronic items. Well cleaned & washed plastic wares are put in polythene bags and sealed it then sealed bags are sterilized in Ethylene oxide chamber.

Sample questions

1. Name the different methods of sterilizing A.I equipments. Describe the method of sterilization by autoclaving.
2. Which gas is used for sterilization of A.I equipments? Write in detail about it.

KNOW - AS YOU GROW

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