CERTAIN HAEMATOLOGICAL PARAMETERS AND BLOOD BIOCHEMICAL CONSTITUENTS IN COWS WITH NORMAL AND IMPAIRED FERTILITY

By

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THESIS

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DECLARATION

I hereby declare that this thesis, entitled **Certain Haematological Parameters and Blood Biochemical Constituents in Cows with Normal and Impaired Fertility** is a bonafide record of research work done by me during the course of research and that this thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.

Mannuthy,
16/10/93

ANIL S. DAS

CERTIFICATE

Certified that this thesis entitled **Certain Haematological Parameters and Blood Biochemical Constituents in Cows with Normal and Impaired Fertility** is a record of research work done independently by Sri. Ani, S. Das under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to him.

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CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

Introduction

INTRODUCTION

The production capacity of cattle, to a very great extent depends on the reproductive efficiency as measured by its ability to conceive and deliver a viable calf each year during its life span. In this context the scientific aspect of reproductive management is of extreme relevance.

Any deviation or prolongation in the breeding rhythm results in a progressive economic loss due to widening of dry periods, reduced calvings and lactation. In Kerala, it is estimated that if the calving interval could be shortened from 19.5 months to 15 months, 18.5 per cent more cows would calve every year, contributing to an additional 2.6 lakh metric tonnes of milk worth Rs. 90 crores.

The reasons of reproductive inefficiency include anatomical and genetic defects, physiological, pathological and managemental factors. Over the last 30 to 40 years there has been a noticeable trend in the causes of infertility in cattle. Although, nonspecific infections due to opportunist pathogens are still important, by far the greatest cause of infertility is poor management of herds. Nutritional status of the animals during the initial lactation period play significant role in the postpartum reproductive performance. There are several reports to indicate that dairy cows deficient in nutrition exhibit low fertility; the main reason being the ration deficient both qulitatively and quantitatively. If the ration is deficient in metabolisable energy the cow mobilises glycogen from muscles resulting in decline of body weight leading to poor fertility. And, afterall, reproduction is considered a luxury function by the animal. Superimposed on energy and protein deficiency there can also be multiple deficiencies of phosphorus, trace elements and certain vitamins. However there appears to be no evidence to show that any single nutrient is required specially for reproduction.

Nutritional errors do not always produce similar clinical signs in all animals in a herd and in certain circumstances individual animal may be specially affected. High yielding cows may not be able to maintain body weight and conceive on a diet which enables low yielding animals to achieve this objective. The relationship between supply of nutrients and reproductive performance is a difficult problem. This results in a risk that the breakdown point in a system, so far as its supply of nutrients for reproduction is considered, may not be recognised, until too late. Application of the knowledge of the nutritional parameters influencing reproduction under these systems could be expected to increase the efficiency of management. Unfortunately, the data on these lines are scanty, particularly in crossbred cows and therefore research on these lines should receive greater emphasis.

Attempts have been made to assess the energy balance of lactating cows by estimating blood metabolites. Although there are several reports to indicate the relationship between the levels of these metabolites and other haematological profile and fertility in purebred cows, literature reveals paucity of such information in crossbred cows. Hence it was proposed to undertake an investigation on the role of certain haematological and blood biochemical parameters in crossbred cows with normal and impaired fertility with the ultimate object of assessing their influence on fertility.

Review of Literature

REVIEW OF LITERATURE

Sexual health control programme primarily aims at achieving and maintaining an optimum reproductive efficiency. There is ample evidence to show that the overall production efficiency of any population of bovines has to be built on a strong and sound foundation of scientific reproductive management. Lowered fertility and infertility of various types adversely affect the reproductive health, it necessarily runs down economic loss on account of loss of production, cost of maintaining non productive animals, due to decrease in the number of calves born and increased depreciation cost. Infertility or sterility presents a varied picture from complete inability to reproduce to lowering of reproductive efficiency in many grades. Thus it becomes imperative to have a full understanding of the reproductive efficiency of cattle to gauge the problem of infertility. Therefore the greatest opportunity to improve the efficiency of reproduction lies in the development of scientific tools to control the various and varied factors which control the specific events of reproduction.

Alarming figures of economic loss have been reported by many from different countries. Infertility has been found to be the sole cause for disposal of 18 to 40 per cent of cows in different parts of world (Rowson, 1960; Namboodiripad, 1977). Louca and Legates (1968) estimated that for everyday a cow failed to conceive beyond 90 to 100 days amounts to a loss of 50 to 70 cents. In terms of currency Arthur (1989) pointed out that the cost for each days extension of the calving interval beyond 365 days can be £3/day/cow. On the basis of above, the national loss to U.K. could be as much as 290 million pounds per annum. Precise information on the magnitude of economic loss on account of infertility in cattle in India is not available, although, there are reasons to believe that a large percentage of cows are being disposed of without taking their full potential for reasons of infertility.

The incidence of infertility is reported to be 17.7 per cent on a limited survey of indigenous cattle in India (Bhattacharya, 1954). Kumar et al.(1986) found reproductive disorders in about 48 per cent of animals in Karnataka. Chetty and Rao (1987) in a survey consisting of 1463 cattle in Andhra Pradesh reported that 341 were anoestrous and 130 were repeat breeders.

In Kerala even with modern husbandry practice a high incidence of infertility in cross bred cattle has been reported. On a survey of 3427 crossbred cows, it was found that the major cause for infertility was anoestrum (30.36%) followed by suboestrum (19.13%), underdeveloped genitalia (12.95%), endometritis (20%) and ovulatory disturbances (8.89%) (Iyer et al., 1992).

The classical description of infertility in cattle falls under the categories of genetic, congenital, hormonal, infectious, pathological, nutritional and managemental causes. There are evidences to indicate that wide variations in haematological and blood biochemical constituents occur during impaired fertility in bovines. Nutritional deficiencies and imbalances have been reported to be the major causes of infertility in cattle (McClure, 1965a, 1968a, Boyd, 1970; Lamond, 1970a; Brochart et al., 1972; Velhankar, 1977; Deshpande, et al., 1978 and Morrow, 1980).

Deficiency of protein, carbohydrates, phosphorus, cobalt, copper, iodine, manganese and Vit. A as causes of impaired fertility have been reported earlier (Roberts, 1971; Morrow, 1980; Arthur, 1989). Most of these deficiencies are reported to be due to multiple deficiencies of proteins, carbohydrates and minerals (Morrow, 1980; Arthur, 1989).

It is accepted that manipulation of nutrient intake does have a characteristic effect on ovary. In cows Wiltbank et al. (1964) and Lamond, (1969, 1970a) reported a relationship of follicular development with nutrient intake. Leathem (1966) opined that undernutrition would reduce secretion of Gonadotrophins from pituitary gland in most species. Furthermore, short term undernutrition reduce follicle numbers and plasma progesterone levels in beef heifers (Hill et al., 1970). An inadequate diet will cause anoestrum in young animals and depress ovarian function in older animals (King, 1971). Boyd (1977) showed experimental evidence to prove that the level of feeding especially of dietary energy intake had significant effect on ovarian activity and oestrus in heifers.

Axelson and Moreley (1976) recorded that crossbred heifers on higher plane of nutrition had better conception rate. Mathai and Raja (1976) reported that Jersey-Sindhi crossbred cows receiving higher plane of nutrition attained puberty earlier. Downie and Gelaman (1976) observed that when body weight and plasma glucose were falling fertility was depressed but, when body weight was falling and blood glucose level rising fertility was good. Leaver (1977) noted that increasing the plane of nutrition of dairy heifers in poor or moderate conditions enhanced pregnancy rate. Velhanker (1977) reported that heifers fed with 120 per cent increased energy level reached puberty early.

Experimental evidences have indicated that the reproductive performance of cows improved and conception took place most readily when body weight was increased due to high plane of nutrition during the breeding season

(Sonderegger and Schurch, 1977; Deshpande, 1978; Laing, 1978; Patil and Deshpande, 1979; Somerville et al. 1979; Francos et al. 1980; Morrow, 1980). Bhaskaran (1981) observed that the mean interval from calving to first oestrum was shorter for cows gaining weight (48±3.35 days) compared to those loosing weight (74.00±7.86 days). Alexander (1983) observed that there was significant difference on the onset of post partum oestrum between cows fed with normal, 115 and 130 per cent of recommended ration. He also observed that the levels of haemoglobin, serum phosphorous, protein and glucose in all the three groups were much higher than those of anoestrous cows. Ducker (1984) found that level of feeding had a marked effect on pregnancy rates to first insemination.

a. **Haemoglobin and Packed Cell Volume**

Rowlands et al.(1957) reported direct correlation between blood cellular changes and fertility in cattle. Adams and Hansel (1953), Adams (1969) and Wagner (1972) reported association of lower haemoglobin (Hb) level with anoestrum and repeat breeding problems in cows. Morrow (1980) recorded that Hb level in anoestrous cows was below 9.80 g per cent compared to 10.60 g per cent in normal cycling cows. The normal values of haemoglobin in cows ranged from 8-15 g per cent and PCV from 24-48 per cent (Blood et al., 1987).

Moddie (1965) reported that haemoglobin and certain biochemical constituents in blood serum during oestrus affected fertility of cows and their reproductive behaviour. Morrow (1977) observed that cows with Hb level varying from 10.20 g per cent to 10.70 g per cent bred earlier compared to those with a Hb level of 9.19 g per cent. Alexander (1983) reported Hb values of 11.10±0.40, 11.52±0.62, 11.58±0.54 and 11.20±0.86 g per cent at 2, 15, 30 and 45 days of postpartum in normal cows. He also did not observe any significant difference in Hb levels between the corresponding stages of cows on higher levels of nutrition. Prasad _et al_. (1984) also observed a correlation between fertility and haemoglobin.

In anoestrus buffaloes, Bansal (1976) and Gupta (1977) reported significantly low haemoglobin compared to normal cycling ones. In anoestrus cows, Morrow (1980) recorded that Hb was below 9.8 g per cent compared to 10.06 g per cent in cows with normal oestrous cycle. Pillai (1980) observed a Hb level of 9.16 g and 9.70 g per cent in anoestrous cows and heifers respectively. Dhoble and Gupta (1981) reported that the Hb level in anoestrous buffaloes was significantly lower (9.82±0.13 g%) when compared to cycling animals (12.52±0.45 g%). The low level of Hb indicated an association of mild anaemia.

Rao *et al*. (1981) reported that Packed Cell Volume (PCV) levels are lower in recently calved animals and in repeaters when compared to normal cycling cows. Naidu and Rao (1982) reported mean Hb level of 8.39±0.92 g per cent in anoestrous and 10.25±1.45 g per cent in normally cycling cows.

Sharma *et al*.(1983) reported that the value of Hb and PCV were low in anoestrous and repeat breeding cows; the Hb values being 9.10±2.5 g per cent, 9.05±2.05 g per cent and 11.95±1.90 g per cent in repeat breeders, anoestrous and normally cycling animals respectively. The PCV levels were 27.51±3.85, 27.10±4.60 and 34.51±8.85 per cent respectively in the groups. Similar observations were made earlier by Roberts (1971) and Samad *et al*.(1980).

Gangwar *et al*. (1984) reported relatively higher values of RBC, PCV and Hb in buffaloes with better fertility. Kumar *et al*. (1985) noticed significantly lower values of Hb and PCV in anoestrous and repeat breeder cows. Kumar *et al*. (1985) observed that Hb levels of repeat breeding cows (8.97±0.77 g%) and anoestrous cows (9.23±0.83g%) are significantly lower than that of normally cycling cows (11.48±0.98g%). PCV values of these cows (27.72±2.61, 28.04±2.66%) were also lower than normally cycling cows (34.67±3.62%).

Kumar et al. (1986) reported that Hb and Total Erythrocyte Count (TEC) were comparatively higher in normal cycling animals than in anoestrous and repeaters which also had mild anaemia. They observed Hb values of 9.51±0.44, 8.91±0.26 and 9.51±0.44 g per cent in normally cycling, anoestrous and repeat breeding animals whereas PCV values were 33.06±0.86, 29.14±1.23 and 30.13±1.96 per cent respectively.

Shrivastava and Kharche (1986) observed that mean Hb percentage increased from 7.67 to 8.0 g per cent in abnormal cycling buffaloes when they came to heat after treatment. Anoestrous animals were having Hb level of 6.6 - 8.6 g per cent whereas normal cycling were having 7.8 - 9.4 g per cent. Pedroso et al. (1986) also reported that Hb level significantly affected fertility.

Gujar et al. (1990) observed that the level of Hb in fertile oestrous group of heifers (11.32±0.21 g %) was significantly higher than that of non fertile oestruses (10.41±0.20 g%). Higher Hb content in fertile oestruses was associated with higher PCV values. They observed mean PCV levels of 38.35±0.71 and 36.38±0.98 per cent in fertile and non fertile oestruses.

Kumar and Sharma (1991) reported that Hb concentration was significantly low in non fertile group adversely affecting the normal reproduction.

Kumar and Sharma (1991) observed significantly lower values of Hb and PCV in anoestrous and repeat breeding cattle. Similarly Ali et al. (1991) also observed significantly lower levels of Hb (7.92 ± 0.25) in anoestrous rural crossbred heifers suffering from malnutrition than in normal cycling heifers.

b. **Phosphorous**

Hignet and Hignet (1951) reported infertility associated with deficiency of phosphorus in cattle. This finding was later supported by Salisbery and Vandemark (1961) Boyd (1970). King (1971). Roberts (1971), Vujoric et al. (1972), Cuenca (1973) Maynard and Loosli (1973), Sattar (1973), Morrow (1977) Deshpande (1979), Iyer and Nair (1979), Samad et al. (1980), Arthur (1989), Pandey et al. (1991).

Patel et al. (1966) observed mean serum phosphorus level as 7.7 ± 0.32 mg%) for Gir cows. King (1971) reported optimum value of serum phosphorus for normal reproductive functions as 5.92 mg per cent whereas Maynard and Loosli (1973) reported a value of 4-9 mg per cent. In Ongole cows, the level was at 6.11±0.39 mg per cent (Rao *et al.*, (1981).

Prasad *et al.* (1984) reported that the blood level of inorganic phosphorus at oestrus averaged 7.7 mg per cent with a range of 3.8-12.19 mg per cent. According to Blood *et al.* (1987) the level was 4-7 mg per cent.

Hignet (1960) recorded occurrence of reproductive failure and ovarian dysfunction at lower phosphorus level. Acharya (1968) observed that lack of phosphorus upsets the proper function of reproductive organs. Morrow *et al.* (1969) substantiated that the number of services per conception decreased as blood phosphorus level was increased. He also observed that low level of phosphorus is one of the causes leading the oestrus becoming non fertile one, possibly because of ovulation defects. Morris (1976) suggested that a blood phosphorus level less than 4 mg per cent indicated low conception rate in dairy cows. A significant decrease in inorganic phosphorus in infertile cows has been reported by Ramnarayana (1979). Bhaskaran and Khan (1981) remarked that marginal deficiency of phosphorus is sufficient to cause disturbance in pituitary ovarian axis without manifestation of specific deficiency symptoms. A positive correlation between disturbances of oestrous cycle and phosphorus deficiency was also reported by Shrivastava *et al.* (1982).

Alderman (1963) reported that deficiency of any one or several of blood calcium, phosphorus, manganese, copper, cobalt and iodine lead to poor reproduction. Ford (1972) reported that fluctuations in the levels of calcium and phosphorus occur with phosphorus deficiency leading to poor fertility. Morris (1976) suggested that a blood phosphorus level less than 4 mg per cent indicated low conception rate in dairy cows. Bodai (1976) observed that low blood phosphorus will lead to low fertility in cattle. Kiatoko *et al*. (1978) also concurred with this. Alexander (1983) recorded a level of 4.66 ± 0.15, 4.48 ± 0.12, 4.80 ± 0.13 and 5.08 ± 0.09 mg per cent of serum phosphorus in cows with normal fertility at 2, 15, 30 and 45 days post partum. However he did not observe any influence of higher nutrition in this level. Pedroso *et al*. (1986) observed that blood phosphorus status significantly influenced fertility in crossbred heifers. In animals with low fertility, Saba *et al*. (1987) observed phosphorus deficiency on analysis of blood samples. Singal *et al*. (1988) also observed the same in infertile dairy cows.

Hignet and Hignet (1951) observed that a high calcium intake and a low or high phosphorus intake or a wide calcium phosphorus ratio or a combination of them retarded fertility. On the contrary, Littlejohn and Louis (1960) found no evidence of reduced fertility associated with imbalance of calcium and phosphorus. However, Boyd (1970) Sampath and Kumar (1979) and Iyer and Nair (1979) concurred with Hignet and Hignet (1951). Samad et al. (1980) also observed that in cows with nonfunctional ovaries, serum phosphorus was significantly low and calcium: phosphorus ratio was wider.

Depke (1980) and Avidar et al. (1980) remarked that there was a highly significant correlation between conception rate and inorganic phosphorus Farray and Hassan (1982) noted poor conception rates in cows and buffaloes with low phosphorus level. Jaskowski (1986) observed low conception in cows with blood phosphorus values below 1.4 m mol/litre. The calcium: phosphorus ratio was somewhat low at 1.18:1 but they did not attribute it to be related to fertility. Kumar et al. 1986 b reported that serum phosphorus level in non fertile oestrous was significantly low. Muffarrege et al. (1986) observed that heifers having blood inorganic phosphorus level at 2.9 ± 1.3 mg per cent failed to conceive whereas those with 3.4 ± 0.9 mg per cent conceived.

Ropstad et al. (1988) reported that inorganic blood phosphorus levels significantly affected number of days from calving to first insemination and number of inseminations per conception. Simeonov et al. (1989) also made similar observations. Pandey et al. (1991) found high inorganic phosphorus levels in heifers at oestrus which conceived than those which did not conceive.

Rao and Rao (1982) reported a significant increase in blood phosphorus level in cycling crossbred heifers at the time of oestrus. Sahukar et al. (1984) observed that serum inorganic phosphorous was maximum during oestrus (6.25±0.433 mg %). Kumar and Sharma (1991) reported that serum phosphorus values of cows in nonfertile heat (4.98±0.08 mg %) was significantly lower than those on fertile heat (6.44±0.42 mg %)

Sane (1972) recorded the mean serum inorganic phosphorus as 5.2 mg per cent in anoestrous Gir cows. Dindorkar and Kohli (1979) found that serum inorganic phosphorus level of anoestrous (5.71 mg%) and cycling cows (8.0 mg%) varied significantly. According to Samad et al. (1980) cows having gonadal hypoplasia and non functional ovaries had significantly lower levels of inorganic phosphorus, (3.31±0.37 and 3.42±0.62 mg % respectively) but calcium phosphorus ratio in these groups was significantly higher than in normal animals. Pillai (1980) found that mean value of serum inorganic phosphorus as 4.05 mg per cent in anoestrous cows. Agarwal et al. (1981) and Naidu and Rao (1982) also observed lower serum inorganic phosphorus levels in anoestrous cows and heifers than in normal cycling cows. Ullan *et al*. (1983) also reported similar findings in buffaloes. According to Prasad *et al*.(1984) the level of inorganic phosphorus at oestrus averaged 7.79 mg per cent with a range of 3.8 to 12.19 mg per cent while during anoestrous the values averaged 6.84 mg per cent with a range of 3.2 to 11.8 mg per cent. Aminudeen *et al*. (1984) recorded low level of serum inorganic phosphorus in physically poor anoestrous cows (3.02±0.04 mg %) than normal cycling animals (4.92±0.27 mg%). Kumar *et al*. (1986) concurred with the above. On the contrary, Shrivasthava and Kharche (1986) did not observe any significant difference in serum inorganic phosphorous level in anoestrus buffaloes before and after treatments. Ali *et al*. (1991) stated that serum inorganic phosphorus was significantly low in anoestrous heifers whereas when they came to first oestrus after improvement of nutritional status showed increased value of serum inorganic phosphorus approximating that of normal cycling ones.

Rao *et al*. (1981) reported that the mean serum inorganic phosphorus in normal (6.11±0.39 mg 5) and repeater cows (6.82±1.13 mg %) were slightly higher though not significant when compared to pregnant ones(5.19±0.36 mg %). But Agarwal *et al*. (1981) and Kumar *et al*. (1986a) found lower levels in repeat breeder cows.

There are ample reports that addition of phosphorus orally or parentrally solve the problem of anoestrum and bring about a positive modulation of fertility in cattle (Deshpande et al.,1978; Morrow, 1980; Samad et al., 1980) Sattar (1973) observed that oral supplementation of phosphorus would improve fertility in dairy cattle The deficiency of phosphorus can be corrected by special feed or by therapeutic measures. It might be associated with higher inorganic phosphorus content in genital secretion of bovines during oestrual phase (Heap and Lamina, 1962; Schultz et al., 1971; Arya and Jain, 1986).

Kulkarni (1973) found that treatment with Tonsphosphan was significantly effective in the treatment of post-partum anoestrum in Gir cows. Porwal et al. (1976) and Sampath and Kumar (1977) found that mineral mixtures can be successfully used for treating anoestrum. Scharp (1979) observed that mean serum phosphorus concentration of cows in infertile dairy herd increased from less than 4.4 mg per cent to 5.8 mg per cent after deflurinated superphosphate was added to drinking water at the rate of 2.5 kg/450 litres once weekly. The first service pregnancy rate increased from 36.5 to 63.2 per cent and the mean calving to conception interval decreased from 109 to 85 days. According to Iyer and Nair (1979) deficient pastures may be treated with super phosphate and sterilized bone meal or dicalcium phosphate added to the ration of cattle to improve fertility. Cates and Christensen (1983) observed that supplementation with 12 g of calcium and phosphorus daily and provision of cereal silage improved conception rate and opined that the improvement of pregnancy rate was due to phosphorus supplementation. Brooks et al. (1984) reported that when phosphorus supplementation in drinking water and injection of a preparation containing phosphorus was given, ovarian activity was restored in anoestrous cows. Gonzalez et al. (1984) reported that when cattle deficient in serum phosphorus was given a mineral mixture containing phosphorus, birth rate increased and abortion rates and calving conception intervals decreased. Singal et al.(1988) observed that when mineral supplements with phosphorus was fed, 40 per cent of previously infertile cattle showed oestrus and conceived.

Mathai et al. (1973) and Kulkarni (1973) found Tonophosphan as effective in hastening postpartum oestrum in cows. Singh et al. (1978) also found that 58.8 per cent of anoestrous cows came into heat following five continuous injections of Tonophosphan. Pargaonkar et al. (1992) and Behera et al. (1993) reported that injectable preparations of phosphorus (Tonophosphan) improved conception rate in anoestrous cows.

c. **Protein**

Reproduction in dairy cows is significantly influenced by the levels of protein in ration (Gould, 1969; Sonderegger and Schruch, 1977; Jorden and Swenson, 1979; Morrow, 1980).

Arthur (1989) recommended that for a dairy cow producing more than 30 kg of milk per day 16 per cent crude protein per dry matter was the optimum.

Gould (1969) suggested that an excess of protein can lower fertility. According to Hewett (1972) there existed a positive relationship between levels of serum protein and fertility. Jorden and Swenson (1979) stated that feeding dietary protein in excess of that required by tissue caused cellular damage resulting in unfavourable uterine or ovarian environment and reduction in fertility. Pedroso et al. (1975) pointed out that length of service period was significantly correlated with blood protein level.

Scott et al. (1982) showed that there was no significant difference in fertility among cows fed with diets containing 45 or 75 per cent rumen degradable protein plus hay and concentrate at a level which provided 85 or 100 per cent predicted metabolisable energy requirements at peak milk production. Kaim et al. (1983) found that neither protein intake not age affected the interval from parturition to the first observed oestrus.

Pyne and Maitra (1979) reported serum protein values for Hariana and Sahiwal as 7.45 gm per cent and 7.61 gm per cent respectively. The normal range of plasma protein reported was 5.7 to 7.1 g per cent (Blood et al., 1987).

In a detailed investigation, Alexander (1983) observed serum protein levels at 2, 15, 30 and 45 days post partum in normal healthy cows as 8.37 ± 0.26, 8.16 ± 0.15, 8.19 ± 0.19 and 8.77 ± 0.19 g per cent respectively. Higher levels of nutrition had shown significant difference in values in day 2, 30, and on the day of oestrous.

Gujar et al. (1990) observed that mean serum protein concentration at fertile and non fertile oestrus were 7.59 ± 0.09 and 6.34 ± 0.12 g per cent respectively in Kankrej heifers.

Kumar and Sharma (1991) reported that mean total serum protein levels in cows at non fertile heat (7.14 ± 0.12 g %) was lower than those on fertile heat (8.45 ± 0.63 g%).

There was no significant difference in the levels of total serum proteins in anoestrous and normally reproducing cows but the anoestrous cows had a lower level than that of normally reproducing ones (Larson and Kendel, 1957; Humana and Ushi, 1973). Patil (1976) observed an increase (0.11g/week) of serum protein in animals exhibiting postpartum oestrum with a decline (0.026 g/wk) in anoestrous cows. Deshpande _et al_.(1979) reported that average value of serum protein in cows exhibiting oestrus was 7.9 gm per cent and anoestrous cows never reached this value. Pillai (1980) found in anoestrus heifers and cows 6.54 and 6.83 g per cent of serum protein respectively. Reheem (1982) and Naidu and Rao (1982) observed that total serum protein levels were significantly lower in anoestrous cows (7.84 ± 1.50 g%) than in cycling ones (9.43 ± 1.22 g%). Aminudeen and Pareek (1984) found that serum protein levels of anoestrus cows (5.48 ± 0.16 g%) was significantly lower than that of normally reproducing cows (6.82 ± 0.52 g%).

However, Samad _et al_. (1980) observed that the total blood protein levels of animals having non functional ovary was significantly higher than that of animals suffering from gonadal hypoplasia.

Agarwal _et al_. (1988) observed that total serum protein values were significantly higher in repeat breeders (9.39 ± 0.63 g%) than in normal cycling animals (8.84 ± 1.22 g%). Similarly, El-Sabaie _et al_. (1988) also found that repeaters had higher albumen globulin ratio than normally cycling animals.

Paul *et al*. (1991) reported that blood protein was higher in pregnant animals than in non cycling animals. Similarly highly significant difference in protein level was reported between non cycling heifers and cows.

d. Glucose

Composition of diet is considered to have a significant influence on the blood glucose level. Level of blood glucose reflects the various oxidative processes and the role of hormones in maintaining blood sugar level (Dixit and Nangia, 1969).

Patil (1976) observed that the levels of serum protein, blood glucose and haemoglobin content are indices for prediction of onset of oestrum in dairy cows. The levels of blood glucose were reported to have good correlation with fertility in cows (McClure 1965b; Lamothe *et al*., 1972; Sane, 1972; Downie and Gelman 1976; Hunter 1977; Deshpande *et al*., 1978; Velhankar 1977; Savoiski *et al*., 1980; Lotthammer 1991; Forshell *et al*., 1991). According to Deshpande (1978) estimation of blood glucose, total protein and body weights can be of use to differentiate whether the cow after calving can be a normal breeder or not.

The blood glucose level in healthy animals ranged from 35 to 65 mg per cent (Dukes, 1955; Setty and Razdan, 1966;

Enkhia *et al.*, 1982; Blood *et al.*, 1987). Bhatia *et al.* (1972) reported that the value of blood glucose ranged from 57.10 to 79.90 mg per cent and 56.71 to 75.60 mg per cent respectively in Haryana pure bred and crossbred heifers. Rao *et al.* (1981) observed that the mean blood glucose level of Ongole cows was 42.23±1.35 mg per cent. Naveen (1983) observed glucose levels ranging from 50.00 to 71.40 mg per cent with mean of 59.79±1.63 mg per cent in normal fertile animals.

The concentration of glucose in the blood varied according to the age, stage of oestrum, pregnancy, lactation, season, environment and nutritional status of animal (Setty and Razdan, 1966; McClure, 1968a; Sane, 1972). Blood glucose of normal cows increased significantly during oestrum (Downie and Gelman, 1976; Deshpande *et al.*, 1978; Rao and Rao, 1982; Derashri, *et al.* 1984; Parmar*et al.* 1986). Deshpande *et al.* (1978) recorded a glucose concentration of 48 to 57 mg per cent during oestrus in normal cows. A significant increase in the glucose concentration in crossbred heifers during oestrum (45.90 mg%) in comparison to that in dioestrum (42.40mg%) was observed by Rao and Rao (1982).

Velhanker (1977) reported seasonal variation in blood glucose level in Gir cows. The lowest value of 46.93 mg per cent was recorded in summer and highest value of 54.06 mg per cent in spring. He also observed that in cows which exhibited oestrus blood glucose levels gradually increased (48.02 to 57.14 mg %) during post-partum period. It decreased in cows (47.88 to 43.44 mg %) which did not show oestrum indicating an optimum amount of physiological blood glucose level for exhibition of oestrum.

Oxenreider and Wagner (1971) reported a significant negative correlation between plasma glucose level and interval to first post partum ovulation. They also demonstrated the importance of high energy diet on young cows during lactation to ensure early ovulation. The blood glucose levels showed a steady increase at the rate of 0.761 mg per cent per week in cows exhibiting post-partum oestrus whereas a steady decrease was noted in anoestrous cows (Patil, 1976). Velhanker (1977) reported higher blood glucose (54.74 ± 4.89mg %) in cows fed with 120 per cent dietary energy which exhibited better reproductive performance than those fed on 100 per cent dietary energy with blood glucose level at 51.16 ± 8.01 mg per cent. A relationship between reduced blood glucose levels at the time of mating and decreased pregnancy rate was demonstrated by McClure (1978). He found that blood glucose values less than 30 mg per cent were associated with reduced fertility.

Reheem (1982) observed that cows with normally functioning ovaries possessed higher levels of blood glucose than those with completely inactive ovaries. Alexander (1983) observed serum glucose levels in normal healthy animals at 2, 15, 30 and 45 days post-partum as 57.40 ± 5.60, 53.42 ± 3.98, 54.98 ± 2.43 and 53.02 ± 1.77 mg per cent respectively. Higher levels of nutrition did not significantly influence the serum glucose level in these animals. Naveen (1983) reported that blood glucose levels of 52.92 ± 3.16 mg per cent, 54.40 ± 1.59 mg per cent, 51.16 ± 2.61 mg per cent and 50.78 ± 1.75 mg per cent at 3-5 months, 6-8 months, 9-11 months and 12 months post partum respectively and recorded maximum conception rate at 6-8 months. Kappel *et al*. (1984) observed that low blood glucose concentration during the first 40-60 days after parturition increased the number of days to conception. Anderson and Emanuelson (1985) reported correlation between the prevalence of hyperketonaemia and herd means of intervals from calving to first and last service. Wembeuer (1987) observed that 28.5 per cent of infertile cows were hypoglycaemic. Kumar and Sharma (1991) found that mean glucose levels of cows at non fertile heat (51.11 ± 2.08 mg%) was lower than those at fertile heat (59.00 ± 3.39 mg%).

The blood glucose levels in anoestrous cows were reported to be significantly lower than those in oestrus

(King, 1971; Patil, 1976; Mokashi et al. 1974; Dhoble and Gupta, 1979; Chauhan and Singh, 1979; Naidu and Rao, 1982; Derashri 1984). Sane (1972) recorded the mean serum glucose levels of anoestrous cows as only 39.40 mg per cent and claimed that the problem of anoestrum could be solved by increasing the serum glucose level to 53 mg per cent by feeding additional energy. Deshpande (1979) and Pillai (1980) observed a mean serum glucose level of 48.49 mg per cent and 51.60 mg per cent in anoestrous heifers and cows respectively. Naidu and Rao (1982) reported mean blood glucose level of 45.33±3.82 mg per cent in anoestrous cows and 51.95±5.41 mg per cent in normal cycling cows respectively. Derashri et al. (1984) found blood glucose in anoestrus Surthi buffaloes as 43.21±6.74 mg per cent compared to 56.31±6.23 mg per cent in oestrus. Agarwal et al. (1985) reported that blood glucose levels (62.90±10.55) in anoestrous crossbred animals were significantly lower than that of normally cycling ones (84.54±13.37 mg %). Pareek and Aminudeen (1985) also observed a low blood glucose in anoestrous animals (37 mg%) which were significantly lower than those of normally cycling ones (46.33 mg%). They also found that at 3 months post partum the blood glucose level rose in animals that resumed normal cycling (46.33 mg%) whereas in anoestrous animals it further declined (37 mg%). Shrivastava and Kharche (1986) observed low blood glucose level (42.5 to 82.50 mg %) in anoestrous buffaloes compared to normally cycling buffaloes (62.50 to 90.00 mg %).

In repeat breeder cows, the concentration of glucose in blood was reported to be 30 to 59 mg per cent which was low in comparison to that recorded in fertile cows (McClure, 1968b; Downie and Gelman, 1976). McClure (1968b) also reported that in cows which showed a conception percentage of 67 to 72 the blood glucose levels ranged from 34.7 to 37 mg per cent whereas in infertile cows the level was below 30 mg per cent. Naveen (1983) observed that in repeaters the blood glucose levels ranged from 30.55 to 67.86 mg per cent with a mean of 53.02±0.69 mg per cent. Agarwal et al. (1985) observed lower blood glucose value in repeat breeding cross bred cattle (78.08±7.56 mg%) compared to normal cycling ones (84.54±13.37 mg%). Parmar et al. (1986) reported that blood glucose level of normally cycling animals varied from 52.45±5.16 mg per cent at early luteal phase to 68.84±10.11 mg per cent at oestrual phase while in repeat breeding cows it ranged from 57.06±4.21 mg per cent at follicular phase to 97.73±9.36 mg per cent at oestrual phase.

Several workers have reported that hypoglycaemia adversely affected the hypothalamo hypophyseal function and reduced the fertility (McClure, 1968a, 1978a; Black et al., 1968; Lamond, 1970a; Sane, 1972; Boyd 1977 and Mathai, 1982). Lamond (1970a) opined that the level of nutrition directly affected the genital tract and growth of follicle and secretion of ovarian steroids which in turn influenced hypothalamo-pituitary function. Roberts (1971) suggested that hypoglyceamia at oestrum or shortly after service may exert a harmful effect on conception by lowering the glucose and glycogen level in the mucosa of the genital tract resulting in lack of energy of spermatozoa or fertilized ova.

Gorohv (1962) obtained 100 per cent conception rate on 21 repeater cows by irrigation of uterus and cervix with a sugar solution prior to insemination. Mathew et al. (1980) and Naveen (1983) obtained significant improvement in conception rate of repeat breeders with post insemination infusion of dextrose. Naveen (1983) also observed that repeaters having blood glucose levels upto 45 mg per cent, 46 to 55 mg per cent and 56 mg per cent and above on treatment with glucose showed conception rate of 66.67 per cent, 46.34 per cent and 47.7 per cent respectively, while those without treatment showed only 15.38 per cent conception rate.

e. Cholesterol

Blood cholesterol level was reported to have good correlation with fertility (Bhattacharya et al., 1972; Velhanker, 1977; Pedroso et al., 1986; Kampal et al., 1990).

Lenon and Mixner (1957) observed total blood cholesterol values as 241.87 mg per cent in pregnant and lactating cows; 96.07 mg per cent in lactating non pregnant cows; 105.63 mg per cent in heifers and 123.60 mg per cent in calves of 3 to 6 months age respectively. Jadhav et al. (1977) reported mean blood cholesterol level as 231.87 mg per cent at 8th week antepartum, 134.57 mg per cent on day of parturition in Gir cows. Murtuza et al. (1978) observed 153.84±5.40 mg per cent of total cholesterol in heifers, 119.41±6.96 mg per cent in empty dry cows, 147.9±6.72 mg per cent in late pregnant cows and 181.43±13.69 mg per cent in early lactating cows respectively. Blood et al. (1987) reported the normal total cholesterol level in blood as 39 to 177 mg per cent and suggested that any deviation from this would cause impaired fertility.

Cholesterol levels showed increasing trend with age (Setty and Razdan, 1966; Eapen and Goswamy, 1970). Cholesterol levels were also influenced by season and showed lower values in summer (144.74 mg %) and in rainy season (138.77 mg%) but much higher values in winter (163.64 mg %)

and in spring (164.81 mg %) in Gir cows (Velhanker, 1977). He also reported that animals with higher values of serum cholesterol exhibited better and consistent reproductive performance.

Bhattacharya et al. (1972) and Rao et al. (1982) recorded significantly higher cholesterol level at oestrus compared to the values recorded during peak luteal activity. Kappal (1984) reported that decreased blood cholesterol level at post partum delayed conception.

At all stages, anoestrous cows had lower cholesterol values than normal cycling cows (Lenon and Mixner 1957; Deopurkar, 1974; Jadhav, 1977; Murtuza et al., 1978; Aminudeen et al., 1984). Pareek and Aminudeen (1985) observed in Rathi cows that cholesterol level in anoestrous (181.61 mg%) was significantly lower than normally reproducing cows (273.33 mg%). Kumar and Sharma (1991) observed that total serum cholesterol was significantly low in cows showing non fertile heat (99.17±1.39 mg%) than those with fertile heat (105.22±2.06 mg%). According to Shrivastava and Kadu (1992) the mean serum total cholesterol in cycling cows (109.29±1.85 mg%) was significantly higher than in delayed pubertal crossbred heifers (97.37±2.15 mg %). Sarvaiya et al. (1993) also observed similarly in Surti buffaloes.

Beneficial effects of dietary supplementation of energy on blood level of cholesterol and reproductive performance were also reported (Saarinen and Shaw, 1950; Aroj _et al_., 1969; Velhanker, 1977).

Materials and Methods

MATERIALS AND METHODS

With the object of studying the influence of certain haematological and biochemical parameters on fertility in crossbred cows, a detailed investigation was undertaken in cows with normal and impaired fertility. Crossbred cows brought for insemination at the Artificial Insemination Centre, Mannuthy and University Livestock Farm, Mannuthy formed the material for the study.

Breeding history and feeding practices of all these animals were collected in detail and were subjected to detailed gynaeco-clinical examination and were divided primarily into two groups.

Group I

Eleven animals which had apparently normal breeding history and which conceived with one or two inseminations were included in group I and were inseminated and followed up.

Group II

The group II consisted of animals that were hard to settle and free from any genital infection but apparently deficient in nutrition. Fifty two such animals were selected to group II.

Ten ml of blood was collected from the jugular vein of all the cows in all the groups test tubes, and was allowed to clot. The serum was separated and collected (Sample A). Another 10 ml of blood was collected in test tubes containing 10 mg of EDTA (sample B).

Using serum from sample A glucose was estimated by O-Toluidine Method using Stangen Glucose Kit** Five ml of reagent was mixed with 0.05 ml of standard (S) and serum (T) and heated for 10 mts in boiling water bath. Then it was cooled and absorbance (A) was read at 630 nm against deionised water (blank) in a spectrophotometer.

$$\text{Glucose (mg\%)} = \frac{\text{A of (T)}}{\text{A of (S)}} \times 100$$

Total protein in serum was estimated by Biuret method (Gornall et al., 1949). Serum protein level below 5.7 g per cent was considered deficient (Blood et al., 1987).

Serum phosphorus was estimated by modified metol method using Stangen Phosphorus Kit** 0.1 ml of serum (T), Standard (S) and de-ionised water (Blank) were pipetted into clean dry test tubes, and 1 ml of Catalyst reagent, 1 ml of Molybdate reagent and 1 ml of Metol reagent were added to all the test tubes. Mixed well and kept in room temperature for 5 minutes. Absorbance (A) was measured on a spectrophotometer at 680 nm within 30 mts.

$$\text{Serum phosphorus (mg\%)} = \frac{\text{A of (T)}}{\text{A of (S)}} \times 5$$

Total cholesterol was estimated by Wybenga and Pileggi's method using Stangen Cholesterol Kit** 0.05 ml of serum (T), Standard (S) and blank (deionised water) were pipetted out into clean dry test tubes. 5 ml of cholesterol reagent was added to each of the test tubes. Mixed well and immediately placed in a boiling water for exactly 90 seconds. Cooled immediately in running tap water and measured the absorbance (A) of serum and standard against blank on a spectrophoto-meter at560 nm within 15 minutes.

$$\text{Total cholesterol (mg\%)} = \frac{\text{A of (T)}}{\text{A of (S)}} \times 200$$

Blood was taken from sample B and haemoglobin was estimated by Sahlis acid hematin method (Schalam, 1975) and Packed Cell Volume (PCV) was determined by Wintrobe hematocrit method (Schalam, 1965). Hb level below 7 g per cent and PCV level below 24 per cent were considered deficient (Blood et al., 1987).

The cows in group II were divided into sub groups A and B after estimation of the blood constituents. Animals in group II A were inseminated without any treatment and results were followed up.

Animals in group II B were administered 15 ml of Tonophosphan* by intravenous injection or 540 ml of 25 per cent Dextrose by intravenous infusion or both based on the deficient blood constituents and these animals were also inseminated and followed up.

The data were collected and subjected to statistical analysis according to Snedecor and Cochran (1976).

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* Tonophosphan (5 ml ampule 20% solution).

Each ml contains Sodium salt of 4-dimethyl amino-2-methyl phenyl-phosphenic acid 0.2 g

For subcutaneous, intramuscular, intravenous use.

Marked by Hoechst India Ltd., Bombay.

** Stangen Immuno Diagnostics, Hyderabad

Results

RESULTS

The study on certain haematological parameters and blood biochemical constituents like Haemoglobin (Hb), Packed Cell Volume (PCV), Protein, Glucose, Phosphorus and Cholesterol was carried out in cows with normal and impaired fertility, in order to assess the influence of these factors on the fertility of crossbred cows. The efficacy of replacement therapy of glucose and phosphorus in deficient animals in improving fertility was also studied. The data collected are presented in tables 1 to 11 and Figures 1 to 11. A total of 63 animals were utilized for the study.

The haematological parameters of animals with normal fertility (Group I) revealed that the Hb values ranged from 6.6 g per cent to 13 g per cent with an average of 10.06 g per cent while that of PCV ranged from 22 per cent to 38 per cent with a mean of 31 per cent (Table 1 & Fig.2).

Among the biochemical parameters of cows in group I, the level of serum phosphorus ranged from 4 mg per cent to 6.85 mg per cent with a mean of 4.85 mg per cent; serum protein from 5.62 g per cent to 10.33 g per cent with a mean of 7.00 g per cent, blood glucose from 29 mg per cent to 63.63 mg per cent with a mean of 46.10 mg per cent and total cholesterol levels from 48 mg per cent to 140 mg per cent with a mean of 95.09 mg per cent respectively (Table 2).

The data regarding the haematological parameters of cows with impaired fertility (Group II) are presented in table 3. Perusal of the data in table 3 revealed that the level of Hb ranged from 6 g per cent to 12.5 g per cent with a mean of 8.085 and PCV from 20 to 36 per cent with a mean of 28.52.

The various biochemical constituents of animals in group II are presented in table 4. It may be observed from the table that the level of phosphorus ranged from 2.57 to 8.85 mg per cent with a mean of 4.175 mg per cent; protein from 3.75 to 11.6 g per cent with a mean of 6.915 mg per cent; glucose from 22 to 81.81 mg per cent with a mean of 47.27 mg per cent and cholesterol value from 48 to 184 mg per cent with a mean of 93.35 mg per cent respectively.

A comparative statement of various blood parameters of animals with normal fertility and animals with impaired fertility deficient in various parameters are presented in table 5 and Fig. 2. Animals with normal fertility recorded an average of 10.06 ± 0.618 g per cent of Hb while animals with impaired fertility registered a level of 6.86 ± 0.075 g per cent. Similarly the mean level of PCV averaged 31.00 ± 1.33 per cent in animals with normal fertility while that of animals with impaired fertility, it was only

21.50$\pm$0.50 per cent. The data on serum phosphorus level of animals with normal fertility and impaired fertility were 4.85$\pm$0.343 mg per cent and 3.65$\pm$0.068 mg per cent respectively. The total serum protein of animals with normal fertility and impaired fertility was 7.00$\pm$0.99 g per cent and 4.57$\pm$0.30 g per cent respectively. The blood glucose level of animals with normal fertility was 46.10$\pm$3.19 mg per cent while that of animals with impaired fertility was 31.13$\pm$0.726 mg per cent. The mean total serum cholesterol for cows with normal fertility was 95.09$\pm$8.67 mg per cent while that of animals with impaired fertility was 71.36$\pm$1.66 mg per cent. All these parameters were significantly higher ($P < 0.10$) in animals with normal fertility than in animals with impaired fertility.

Overall conception rate of animals with normal fertility (Group I) is presented in table 6. It may be observed from the table that 9 out of 11 cows conceived registering a conception rate of 81.8 per cent.

Overall conception rate of animals with impaired fertility without any treatment (Group II A) is presented in Table 6. Perusal of data revealed that out of 29 animals 18 were inseminated and only two animals conceived giving a conception rate of 11.1 per cent.

The overall conception rate of animals with normal and deficient levels of various parameters of Group I and II are presented hereunder.

The conception rate of animals with normal levels of haemoglobin and animals with low levels of haemoglobin are presented in table 7 and Fig.3. Perusal of data reveal that out of 22 animals with normal level of Hb, 11 animals conceived registering a conception rate of 50 per cent while none of the 7 animals with low level of Hb conceived. The difference in conception rate was significant between the groups ($P < 0.10$)

The data regarding the conception rate of cows with normal levels of PCV and deficient levels of PCV are presented in table 7 and Fig. 4. It may be observed from the table that a conception rate of 40.74 per cent was recorded with 11 out of 27 cows conceiving with normal levels of PCV. The three animals with low levels of PCV did not conceive.

It may be noted from the data regarding the influence of phosphorus of conception rate presented in table 7 and Fig.6. that out of 12 animals deficient in phosphorus only one animal conceived (8.3%); the number of animals conceived with normal phosphorus levels was 10 out of 14 (71.4%). The difference between the 2 groups was statistically significant ($P < 0.01$).

Similarly it could be seen from table 7 and Fig.5 that out of 20 animals with normal serum protein level, 15 animals were inseminated and 7 conceived recording a conception rate of 46.7 per cent. On the other hand, out of 5 animals with low protein only two conceived; the conception rate being 40 per cent. On statistical analysis the difference was not significant.

The data of conception rate of animals with normal and low level of glucose is presented in table 7 and Fig.7. Perusal of data revealed that out of 13 animals inseminated with deficient glucose, one animal conceived (7.69 per cent) while out of 10 animals inseminated with normal level of glucose 7 conceived (70 %). This difference was statistically significant ($P < 0.01$).

From table 7 and Fig.8 it may observed that out of 15 animals with low level of cholesterol only two conceived whereas out of 13 animals with normal level of cholesterol 9 animals conceived. The conception percentage for the two groups being 13.33 and 69.20 respectively. The difference between the groups is statistically significant ($P < 0.01$).

The overall conception rate of animals treated for deficiency based on blood parameters (Group II B) is presented in table 8. Out of 23 animals belonging to this group, 22 animals were inseminated of which 16 conceived recording a conception rate of 77.77 per cent.

The data regarding the conception rate of animals deficient in phosphorus and treated with Tonophosphan are presented in table 9 and Fig. 9. It may be observed from the table that 5 out of 7 cows treated with Tonophosphan became pregnant giving a conception rate of 71.42 per cent while in the control group which did not receive any treatment only one cow conceived out of 4 recording a conception rate of 25 per cent.

The data on the conception rate of animals treated with glucose are presented in table 10 and Fig.10. It may be revealed from the table that out of 4 animals treated with glucose 3 cows conceived recording a conception rate of 75 per cent. In the control group, deficient in glucose, but not treated only one out of 8 cows conceived giving a conception rate of 12.5 per cent.

The data regarding the conception rate of animals treated with both glucose and phosphorus are presented in table 11 and Fig.11. Perusal of data revealed that out of 8 cows treated and inseminated 7 conceived recording a conception rate of 87.5 per cent while in the control group, deficient in both, but not treated, none of the animals conceived. Statistical analysis revealed highly significant difference in conception rate between the groups ($P < 0.01$).

Tables

Table 1. Haematological parameters of animals with apparently normal fertility (Group I)

Sl.No.	Haemoglobin (g%)	Packed Cell Volume (%)
1	10.6	32
2	12	36
3	9	30
4	7	26
5	10	31
6	12	43
7	10	30
8	11.5	32
9	13	38
10	9	30
11	6.6	22
Mean	10.06 ± 0.618	31 ± 1.33

Table 2. Blood biochemical parameters of animals with normal fertility (Group I)

Sl. No.	Phosphorous (mg %)	Protein (g %)	Glucose (mg %)	Cholesterol (mg %)
1	4.06	6.24	40.70	60
2	4.14	6.52	40.90	96
3	5.00	6.14	54.80	140
4	4.72	5.99	45.40	108
5	5.00	5.62	40.90	88
6	6.85	8.50	59.09	102
7	6.57	8.80	63.63	104
8	6.85	10.33	50.00	136
9	4.00	7.46	40.90	96
10	4.10	5.70	41.80	68
11	4.01	5.72	29.00	48
Mean	4.85	7.00	46.10	95.09

Table 3. Haematological parameters of animals with impaired fertility (Group II)

Sl.No.	Haemoglobin (g%)	Packed Cell Volume (%)
1.	6.2	25
2.	9	32
3	7.5	29
4	6.8	29
5	8.4	32
6	7	29.4
7	7	27
8	6	24
9	8	26
10	6.5	24
11	6.5	24
12	11	34
13	8	24
14	6	26
15	7.2	24
16	6.4	22
17	6.6	20
18	9	30
19	10	34
20	11	36
21	9	28
22	10	29

Table 3 contd.....

Sl.No.	Haemoglobin (g%)	Packed Cell Volume (%)
23	12.5	36
24	8.5	24
27	8	25
28	7	23
29	9.5	28
30	6	26
31	7.6	30
32	8.2	31
33	6.4	26
34	8.5	34
35	7.5	28
36	7.5	28
37	11.5	32
38	11.5	34
39	9	34
40	9	34
41	8.5	30
42	6.5	24
43	12	34
44	6.6	20
45	6	26
46	7.5	24
47	9	28

Table 3 contd...

Sl.No.	Haemoglobin (g%)	Packed Cell Volume (%)
48	7.5	28
49	9.5	28
50	7	24
51	7	22
52	7.5	32
Mean	8.085	28.52

Table 4. Blood biochemical parameters of cows with impaired fertility (Group II)

Sl. No.	Phosphorous (mg %)	Protein (g %)	Glucose (mg %)	Cholesterol (mg %)
1	3.28	3.85	81.81	60
2	3.85	8.33	31.8	72
3	3.85	8.51	27.27	60
4	3.71	6.66	45.44	106
5	3.14	6.24	31.8	64
6	4.00	4.01	22.0	56
7	3.14	8.03	88.1	104
8	4.57	6.88	40.90	73
9	3.85	6.50	29.00	184
10	8.85	6.12	34.0	74
11	7.42	8.85	34.0	72
12	3.00	6.88	34	72
13	3.90	9.56	30.90	78
14	3.70	9.37	45.0	72
15	3.70	8.5	30.0	71
16	8.50	11.6	39.9	176
17	3.40	8.03	73.0	70
18	3.42	7.68	41.2	168
19	3.50	7.12	59.0	174
20	5.86	7.26	33.4	70
21	8.26	6.12	27.5	76

Table 4 contd....

Sl. No.	Phosphorous (mg %)	Protein (g %)	Glucose (mg %)	Cholesterol (mg %)
22	5.65	5.73	27.3	75
23	5.86	5.93	30.2	74
24	4.56	6.31	26.0	84
25	4.78	6.12	27.1	112
26	8.47	7.65	49.9	72
27	5.00	6.88	29.2	76
28	4.34	5.73	41.7	78
29	6.08	6.88	32.6	73
30	2.57	6.25	36.33	96
31	3.86	6.56	40.90	48
32	2.86	5.10	36.33	56
33	2.59	3.75	63.63	112
34	3.57	7.07	54.50	108
35	4.77	6.66	36.36	108
36	4.70	6.60	36.30	100
37	3.42	5.72	31.8	60
38	2.79	6.56	39.4	106
39	3.00	9.18	40.9	92
40	3.42	10.33	69.0	86
41	3.71	7.26	64.0	164
42	3.57	8.80	40.9	144
43	3.80	8.22	35.0	176
44	3.40	8.03	63.0	80

Table 4 contd....

Sl. No.	Phosphorous (mg %)	Protein (g %)	Glucose (mg %)	Cholesterol (mg %)
45	3.18	10.33	59.0	112
46	3.10	6.50	40.0	106
47	3.42	7.46	39.9	96
48	3.62	6.12	36.86	84
49	3.42	6.50	56.0	100
50	2.71	6.12	36.36	60
51	4.76	5.73	36.36	64
52	4.10	6.20	34.20	80
Mean	4.175	6.915	47.27	93.35

Table 5. Haematological and blood biochemical parameters of cows with normal and impaired fertility

Blood constituents	Cow with normal fertility	Cow with impaired fertility	't' value
Haemoglobin (g %)	10.06±0.618 (11)	6.86±0.075 (12)	6.0124*
Packed cell volume (%)	31.00±1.33 (11)	21.50±0.50 (6)	6.6947*
Serum Phophorous (mg %)	4.85±0.343 (11)	3.65±0.068 (32)	4.6690*
Total serum protein (g %)	7.00±0.99 (11)	4.57±0.30 (6)	3.3731*
Blood glucose (mg %)	46.10±3.19 (11)	31.13±0.726 (28)	4.5127*
Total serum cholesterol (mg %)	95.09±8.67 (11)	71.36±1.66 (33)	2.7146*

Numbers in parenthesis indicate number of observations

* - 't' value is significant at 10 per cent level

Table 6. Overall conception rate of animals with normal fertility (Group I) and animals with impaired fertility without treatment (Group IIA)

Group	Number observed	Number insemented	Number conceived	Conception rate (%)
Normal fertility (Group I)	11	11	9	81.80
Impaired fertility without treatment (Group IIA)	29	18	2	11.11

Table 7. Conception rate of cows with normal and low levels of different haematological and blood biochemical constituents (Group I and Group IIA combined)

	Normal			Low			
	No. in-semina-ted	No. con-cei-ved	Conce-ption rate (%)	No.in-semina-ted	No. con-cei-ved	Conce-ption rate (%)	X^2 value
Haemoglobin	22	11	50.00	7	0	0	3.85*
Packed cell volume	27	11	40.75	3	0	0	0.57
Phosphorus	14	10	71.40	12	1	8.30	10.74**
Protein	15	7	46.70	5	2	40.70	0.07
Glucose	10	7	70.00	13	1	7.69	7.12**
Cholesterol	13	9	69.20	15	2	13.33	6.93**

* Significant at 5% level ** Significant at 1% level

Table 8. Overall conception rate of animals with impaired fertility after treatment (Group IIB)

Number observed	Number insemented	Number conceived	Conception rate (%)
23	22	16	77.77

Table 9. Conception rate of animals treated with phosphorous alone (Group II)

Group	No. observed	No. deficient in phosphorous alone	No insemiated	No conceived	conception rate(%)
Treated	23	7	7	5	71.42
Not treated	29	4	4	1	25.00

$X^2 = 1.37$

Table 10. Conception rate of animals treated with glucose alone (Group II)

Group	No. observed	No. deficient in glucose alone	No inse-miated	No con-ceived	conce-ption rate(%)
Treated	23	4	4	3	75.0
Not treated	29	8	8	1	12.5

$X^2 = 1.75$

Table 11.Conception rate of animals treated with both glucose and phosphorous (Group II)

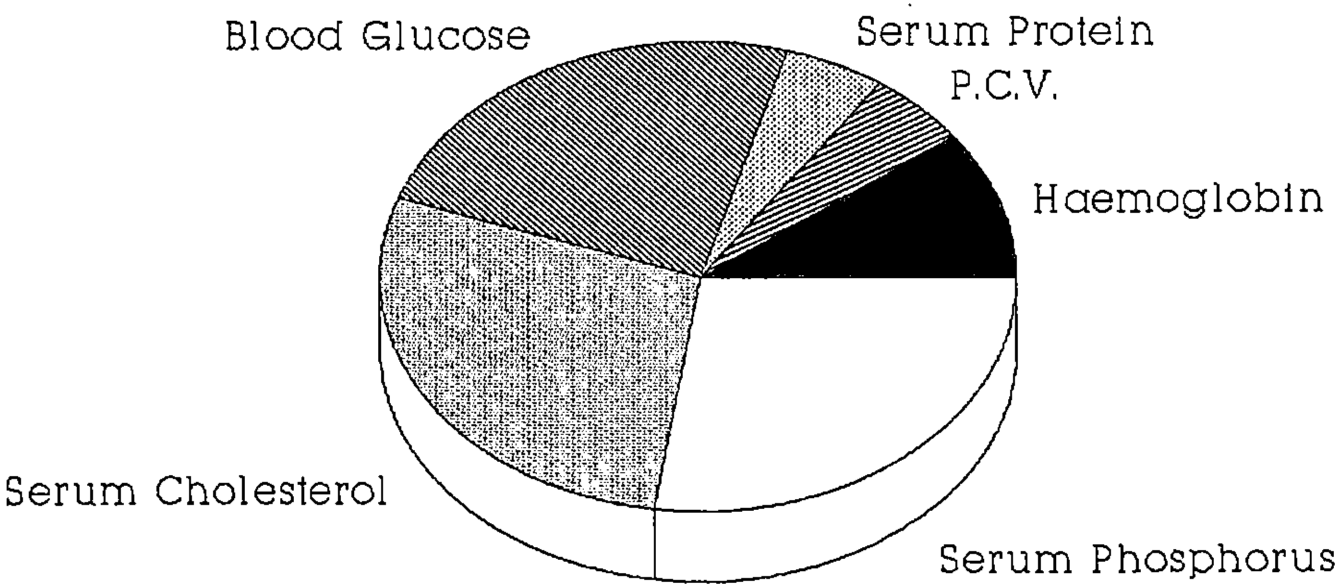
Group	No. observed	No. deficient in phosphorous and glucose	No inse-miated	No con-ceived	conce-ption rate(%)
Treated	23	8	8	7	87.5
Not treated	29	8	8	0	0.0

$X^2 = 9.14$**

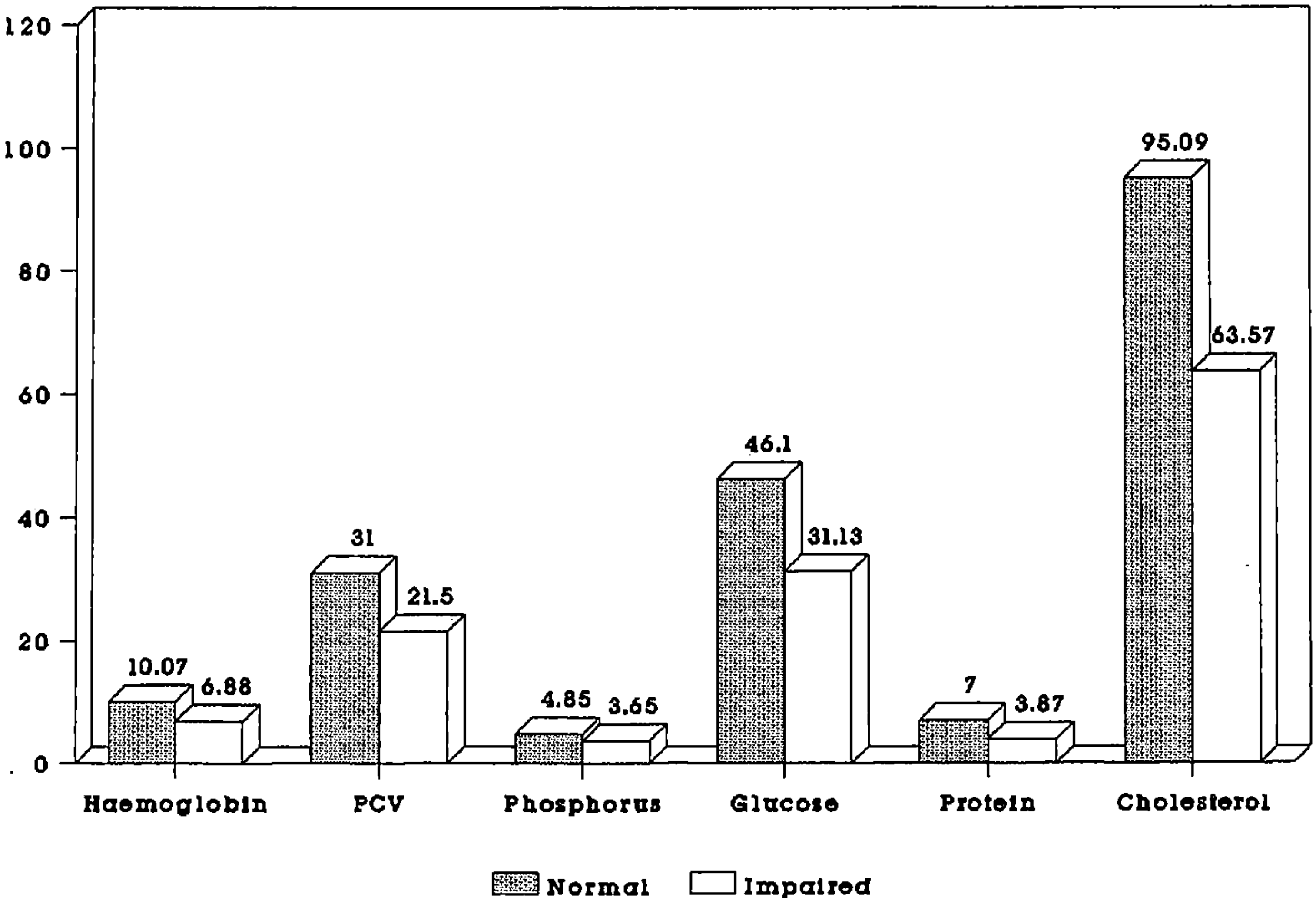
** Significant at 1% level.

Illustrations

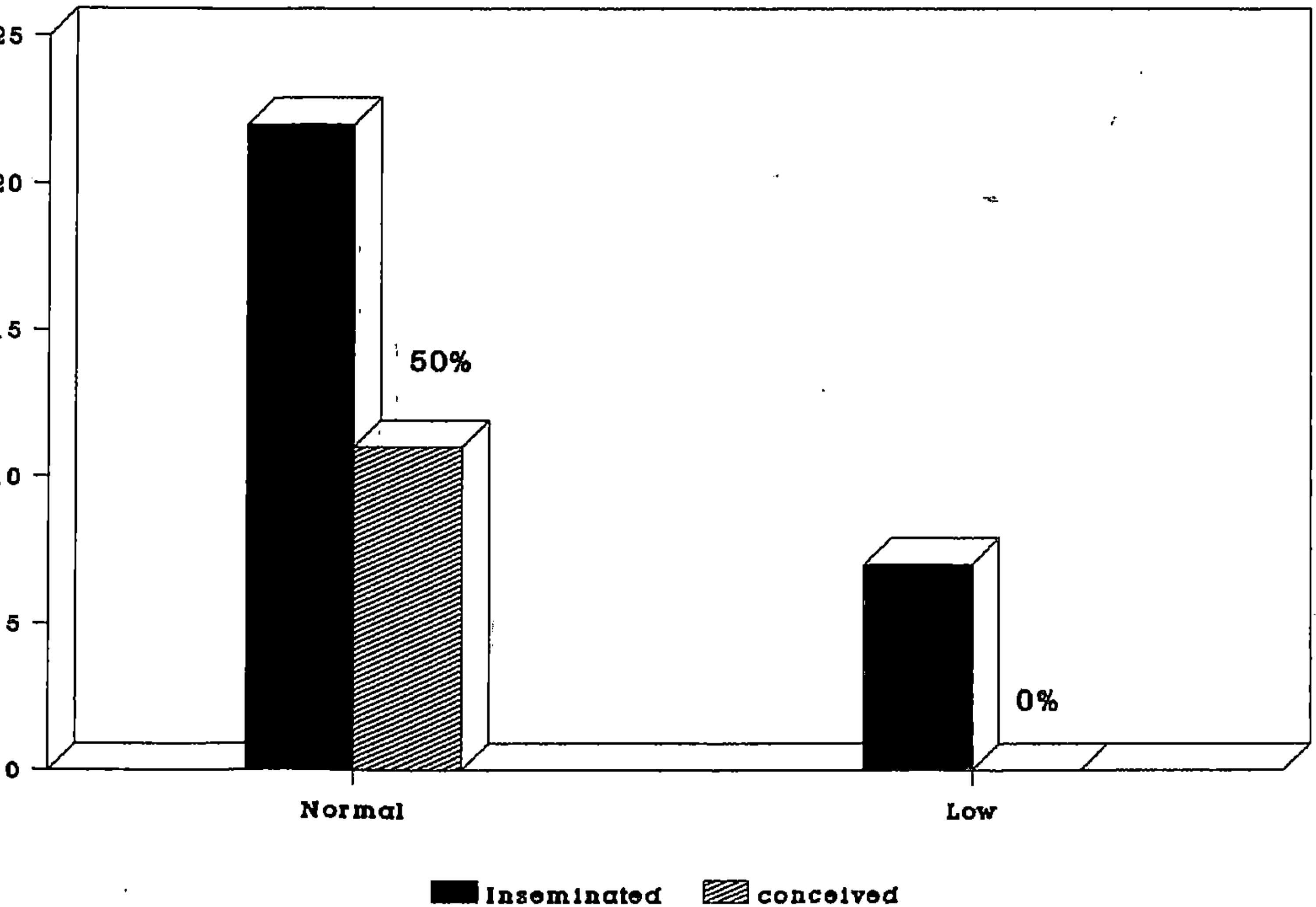
MAGNITUDE OF INFERTILITY DUE TO HAEMATOLOGICAL AND BLOOD BIOCHEMICAL PARAMETERS VIDE TABLE No.5



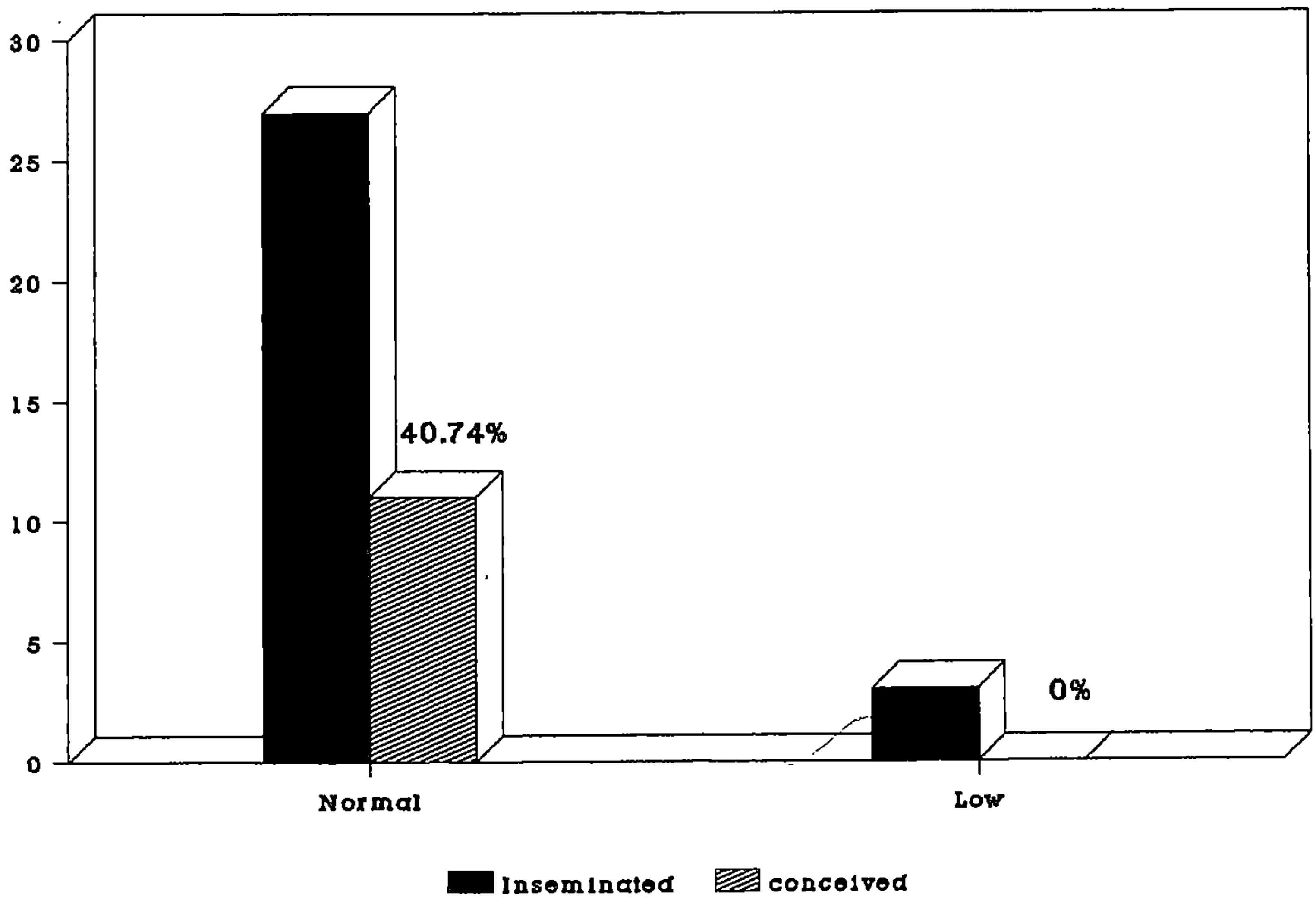
BLOOD CONSTITUENTS IN ANIMALS WITH NORMAL AND IMPAIRED FERTILITY



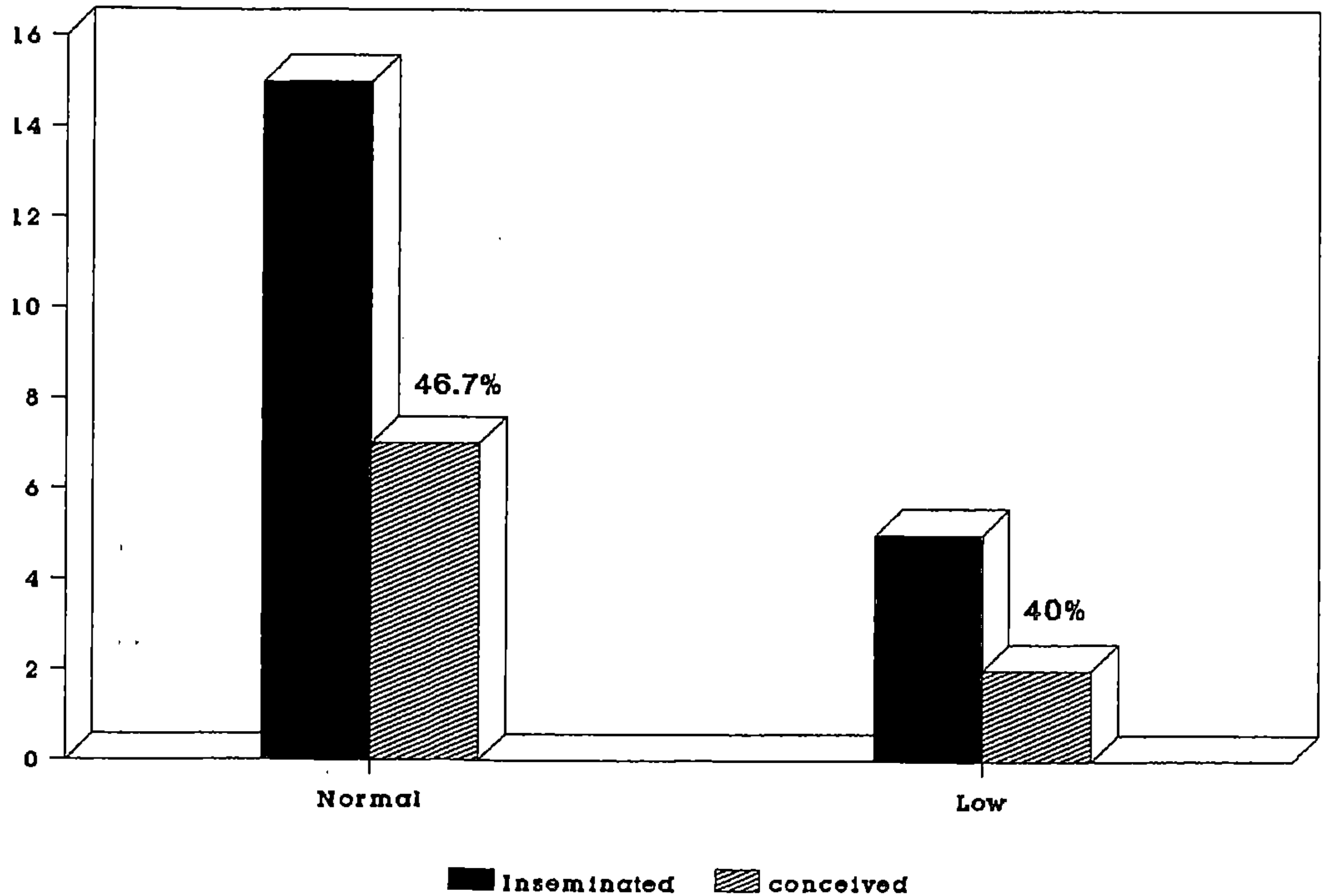
CONCEPTION RATE IN ANIMALS WITH LOW AND NORMAL LEVELS OF Hb.



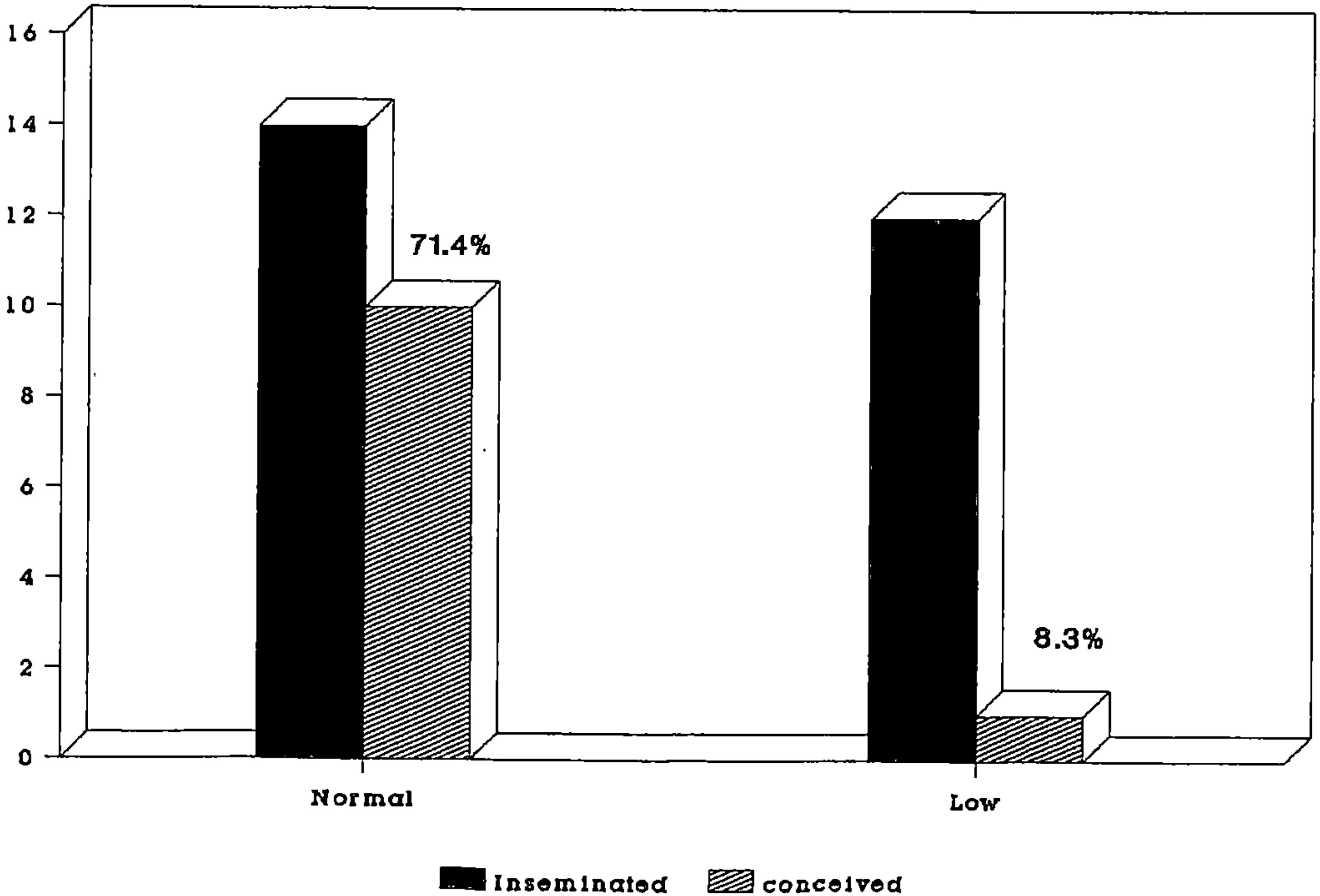
CONCEPTION RATE IN ANIMALS WITH LOW AND NORMAL LEVELS OF PCV



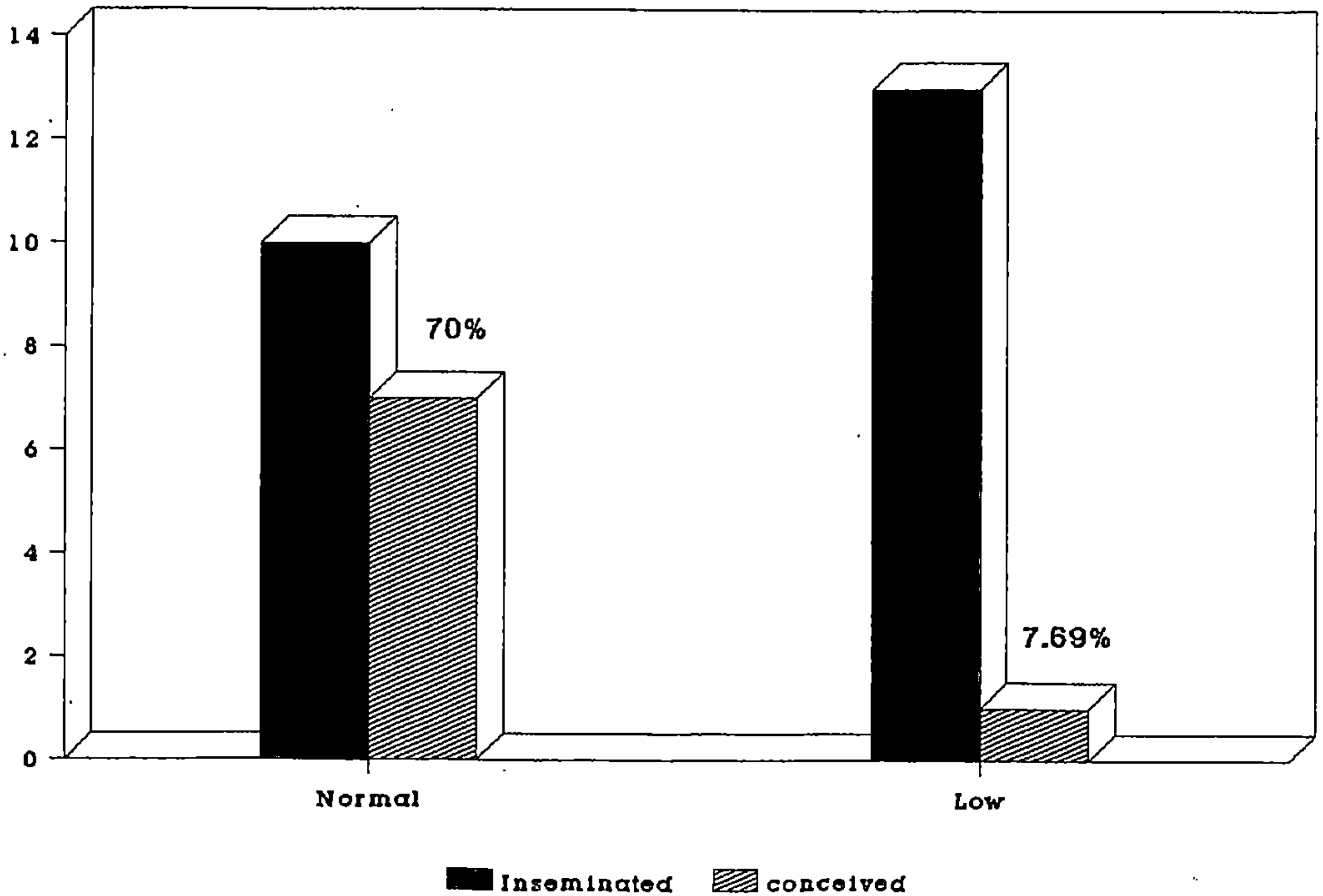
CONCEPTION RATE IN ANIMALS WITH LOW AND NORMAL LEVELS OF TOTAL SERUM PROTEIN



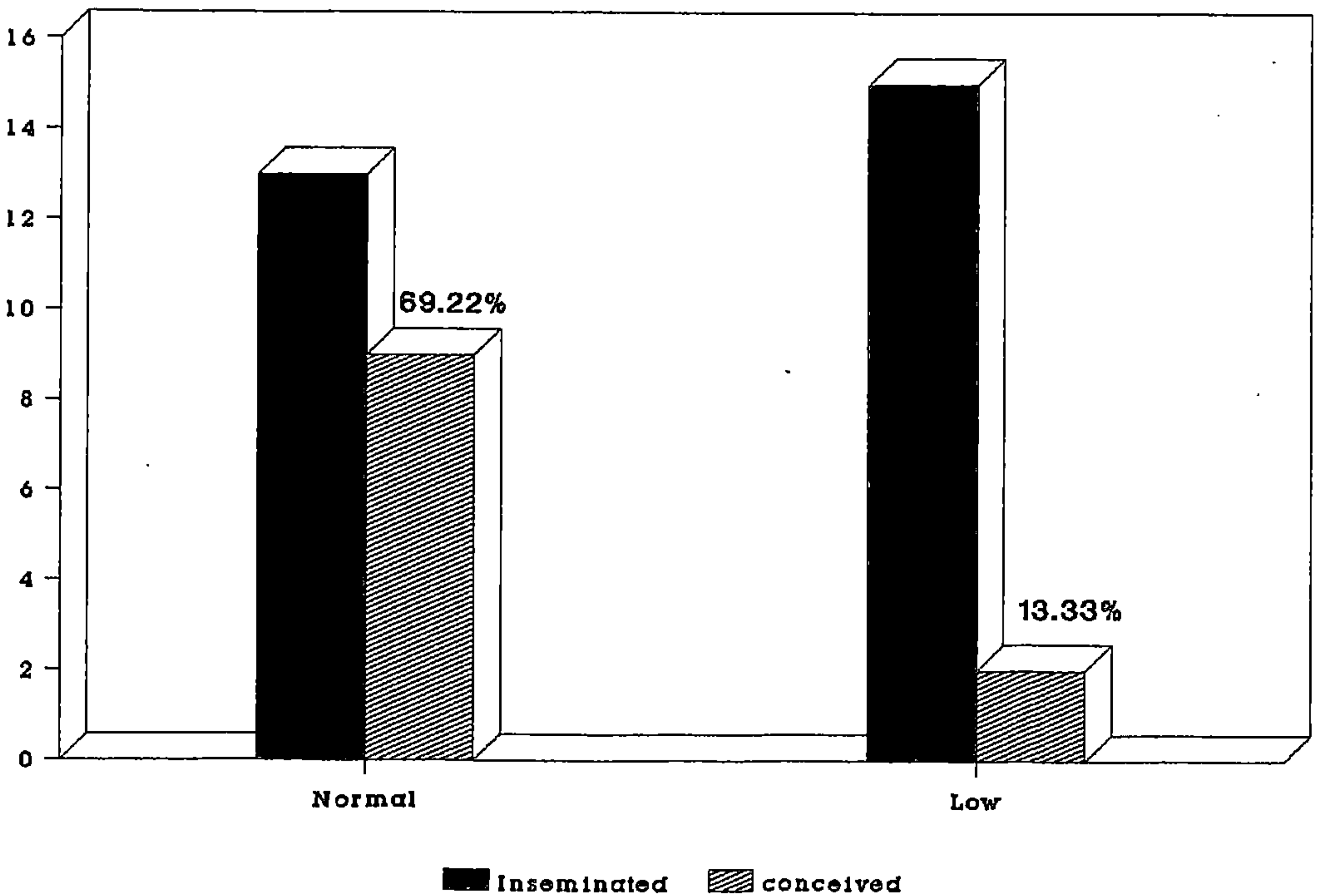
CONCEPTION RATE IN ANIMALS WITH LOW AND NORMAL LEVELS OF SERUM PHOSPHORUS



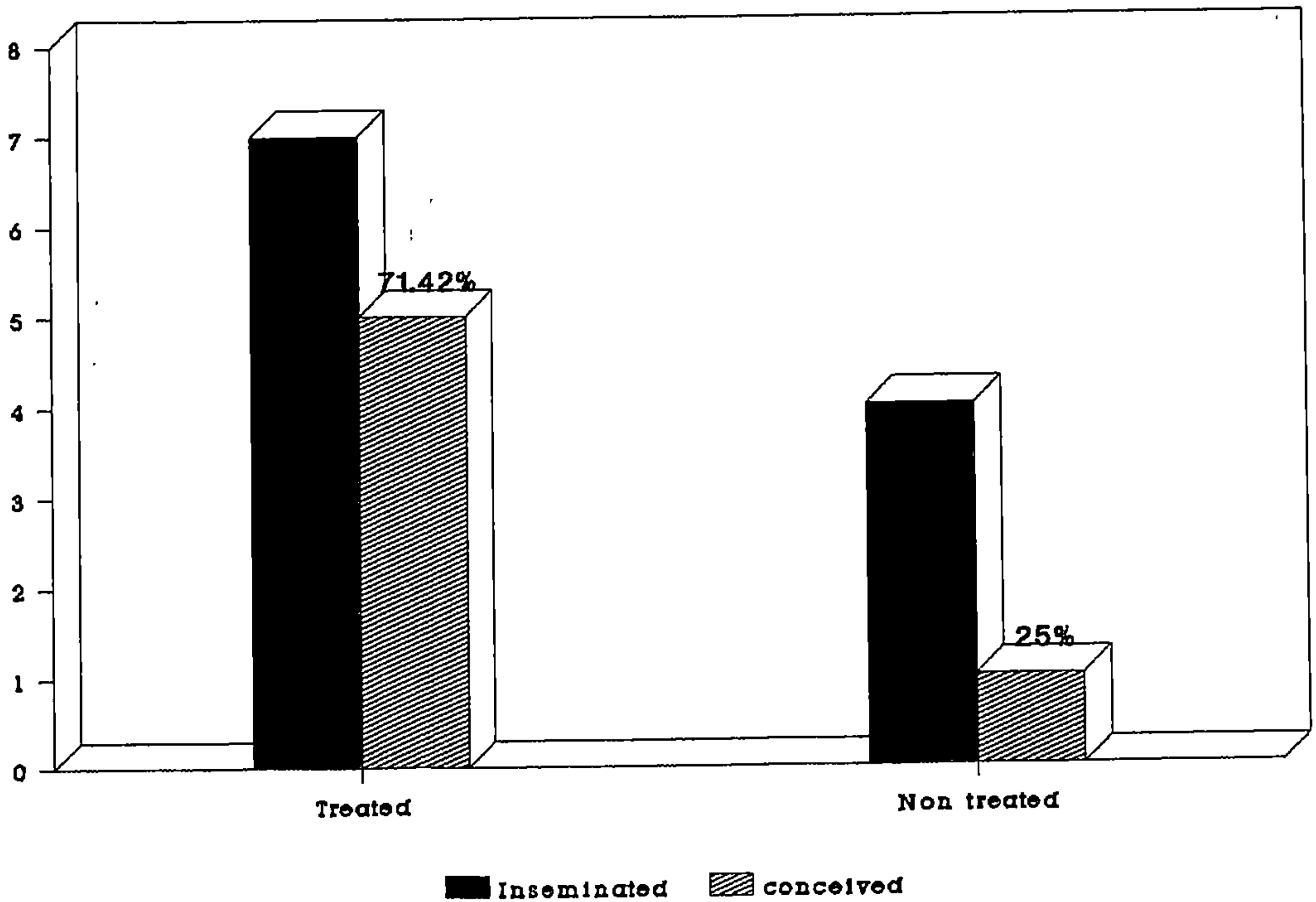
CONCEPTION RATE IN ANIMALS WITH LOW AND NORMAL LEVELS OF BLOOD GLUCOSE



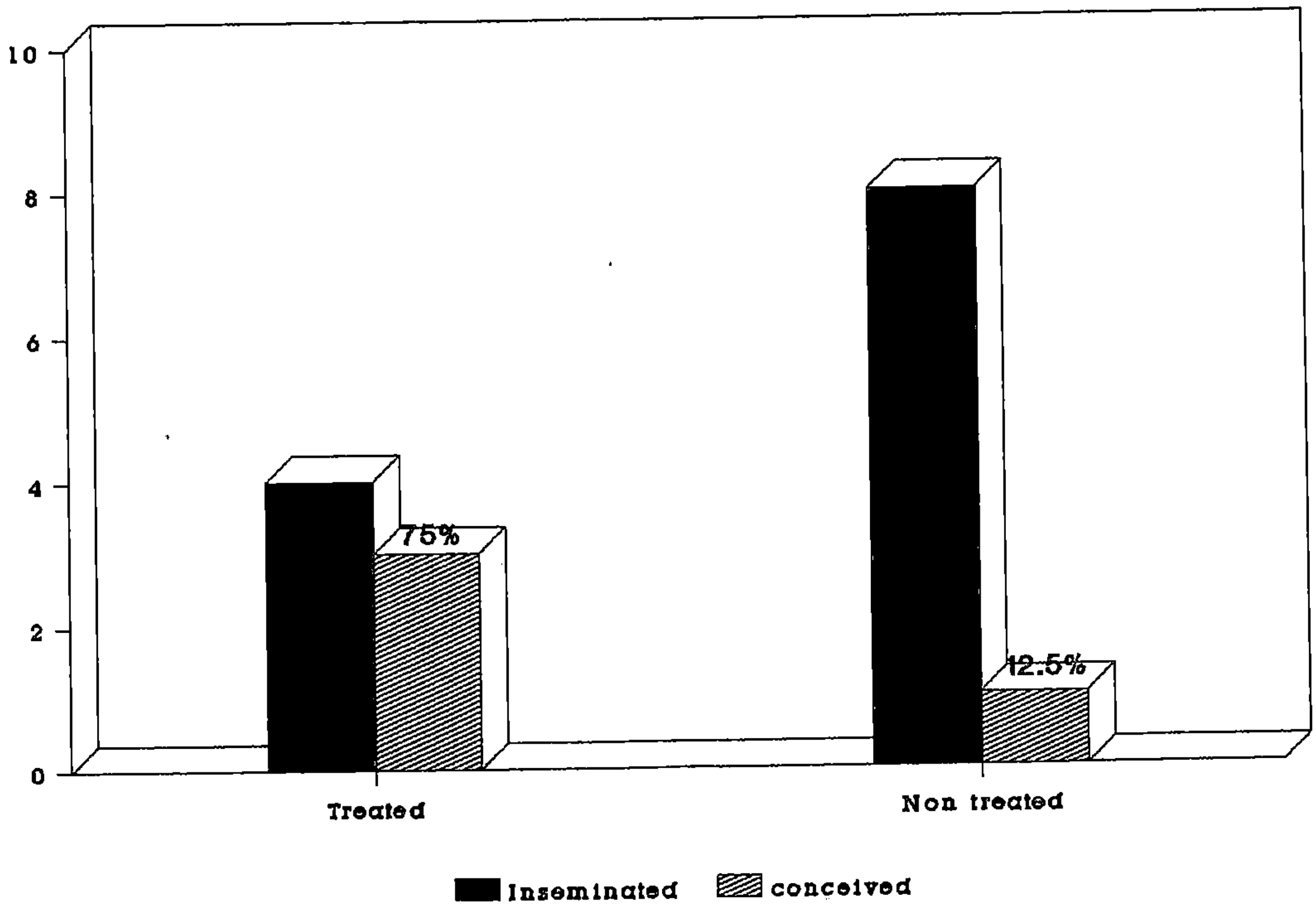
CONCEPTION RATE IN ANIMALS WITH LOW AND NORMAL LEVELS OF TOTAL SERUM CHOLESTEROL



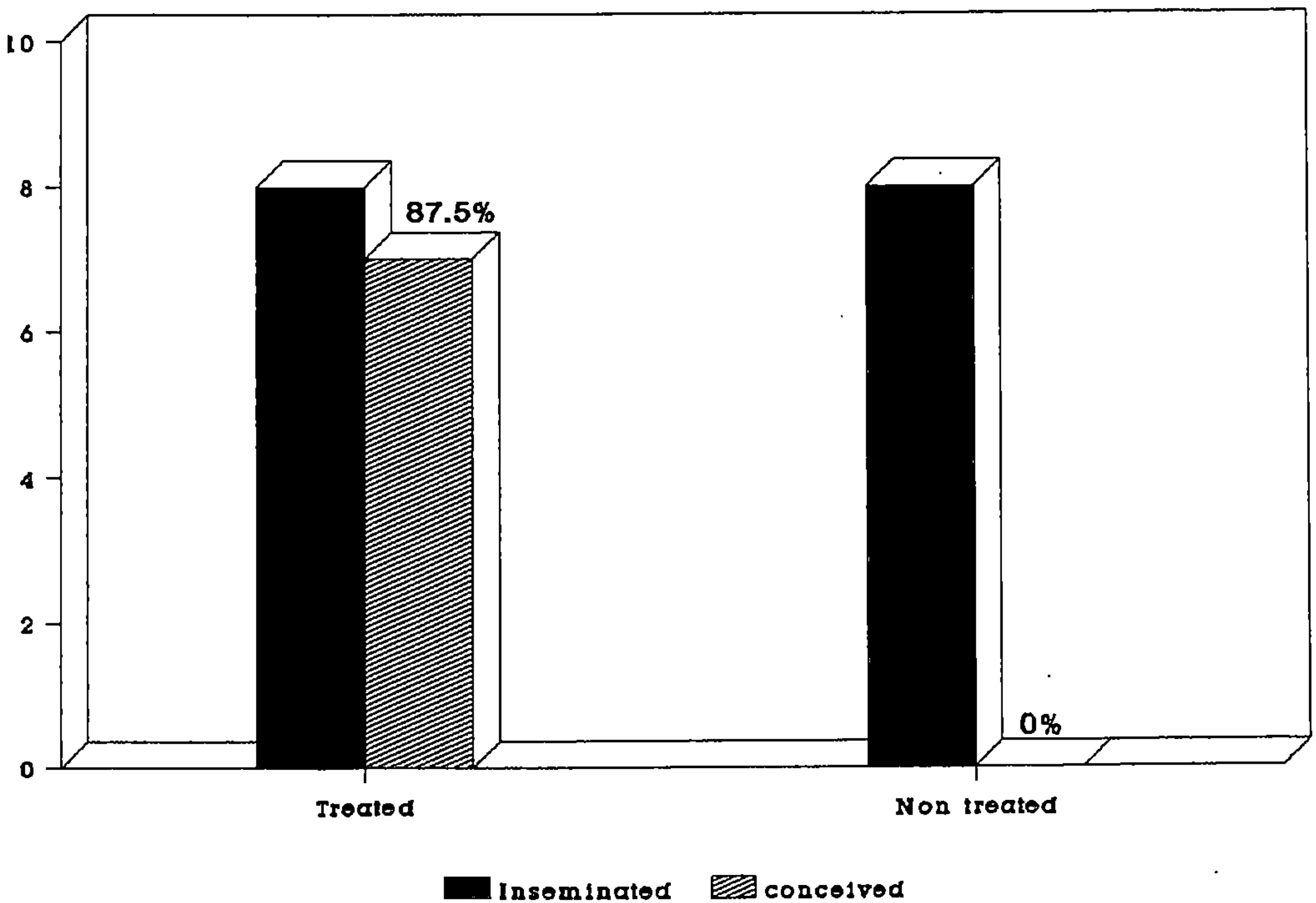
CONCEPTION RATE IN ANIMALS TREATED WITH PHOSPHORUS



CONCEPTION RATE IN ANIMALS TREATED WITH GLUCOSE



CONCEPTION RATE IN ANIMALS TREATED WITH GLUCOSE AND PHOSPHORUS



Discussion

DISCUSSION

With the object of ascertaining the influence of certain haematological and biochemical parameters on fertility in cross bred cows, a detailed investigation was undertaken to assess the levels of haemoglobin (Hb), packed cell volume (PCV), protein, phosphorus, glucose and cholesterol in cows with normal and impaired fertility. A total of 63 animals were selected for the study. The role of these parameters on the fertility of crossbred cows is discussed here under.

Perusal of table 1 revealed that the Hb level in cows, with normal fertility ranged from 6.6 g per cent to 13 g per cent with an average of 10.06 g per cent. Morrow (1980) observed an average of 10.60 g per cent in normally cycling cows. Alexander (1983), Blood _et al_. (1987) and Gujar _et al_. (1990) also reported similar values in animals with normal fertility. Kumar and Sharma (1991) observed a Hb value of 11.01 ± 0.21 g per cent in normal fertile cows.

In the present study, the level of PCV ranged from 22 per cent to 38 per cent with a mean of 31 per cent (Table 1) in cows with normal fertility. Sharma _et al_. (1983) recorded a PCV value of 34.51 ± 8.83 per cent in normally cycling animals. Similar observations were also made earlier by Roberts (1971) and Samad et al. (1978). Grangwar et al. (1985) also reported higher PCV values in buffaloes with better fertility. Gujar et al. (1990) also observed that the average level of Hb in fertile group of heifers as 11.32±2.31 g and suggested that higher Hb content was associated with higher PCV values.

The data regarding serum phosphorus, serum protein, blood glucose and cholesterol of cows with normal fertility are presented in Table 2. The level of serum phosphorus ranged from 4.0 mg per cent to 6.8 mg per cent with a mean of 4.85 mg per cent. King (1971) suggested an optimum values of serum phosphorus for normally reproducing cows as 5.42 mg per cent. Maynard and Loosli (1973) also reported a similar range. But in Ongole cows, Rao (1981) recorded a higher mean of serum phosphorus at 6.11±0.39 mg per cent. However, the observation of Alexander (1983) at different days of post partum in normal cows are in agreement with the present observation. Prasad et al. (1984) reported a wider range of serum inorganic phosphorus at oestrus from 3.8 to 12.12 mg per cent, although, Blood et al. (1987) reported a narrow range of 4-7 mg per cent. Muffarege et al. (1986) observed the mean blood phosphorus level of heifers that conceived to be 3.4±0.9 mg per cent. Kumar and Sharma (1991) also reported similarly. The variations observed could be due to the difference in breed, age and different feeding practices of the animals studied.

The data in table 2 showed that the mean serum protein level in cows with normal fertility ranged from 5.62 g per cent to 10.33 g per cent with a mean of 7.00 g per cent. This is almost in agreement with the earlier reports. The average value of serum protein recorded in cows were 7.9 g per cent (Deshpande <u>et</u> <u>al</u>., 1978) and 7.45 g per cent and 7.61 g per cent respectively in Haryana and Sahiwal cows (Pyne and Maitra, 1979). Reheem (1982) and Naidu and Rao (1982) observed mean serum protein in normal cycling cows as 9.43±1.22 g per cent. Alexander (1983) observed serum protein level at 2, 15, 30 and 45 days post partum in normal healthy cows as 8.37±0.26, 8.16±0.15, 8.19±0.19 and 8.77±0.19 g per cent respectively. According to Aminudeen <u>et</u> <u>al</u>. (1984) mean serum protein level of normally reproducing cows was 6.82±0.52 g per cent. Gujar <u>et</u> <u>al</u>. (1990) also found that mean serum protein level in Kankrej heifers at fertile heat was 7.59±0.09 g per cent. Kumar and Sharma (1991) also noted similar values in fertile heat. The mild variation observed in the serum protein level could be attributed to differences in the breed, management and nutritional level of the animals. However, the present finding is in overall agreement with the earlier reports for normal cows.

The level of blood glucose in animals with normal fertility ranged from 29 mg per cent to 63.63 mg per cent with a mean of 46.10 mg per cent (Table 2). The blood glucose level in healthy animals was reported to be 35 to 65 per cent (Dukes, 1955; Setty and Razdam 1966; Enkhia et al. 1982; Blood et al. 1987). This is essentially in keeping with the present observation. The blood glucose level of crossbred heifers during oestrum were reported as 42.40 mg per cent (Rao and Rao, 1982) and 48-57 mg per cent (Deshpande et al., 1978) and 51.95 mg per cent (Naidu and Rao, 1982). Naveen (1983) found that blood glucose level in normal fertile cows ranged from 30.55 to 60.86 mg per cent with a mean of 59.79 ± 1.63 mg per cent. Alexander (1983) observed that serum glucose levels in normal healthy cows at 2, 15, 30 and 45 days post partum as 57.40 ± 5.60, 53.42 ± 3.98, 54.98 ± 2.43 and 53.02 ± 1.77 mg per cent respectively. Pareek and Aminudeen (1985) observed mean blood glucose levels of normally cycling animals to be 46.33 mg per cent. The value of mean serum glucose obtained in the present study also concurs with the above observation. Variations observed in normal values could be due to differences in the experimental animals, type of feed, etc.

It was observed that the total blood cholesterol level in normal cows ranged from 48 mg per cent to 140 mg per cent with a mean of 95.09 mg per cent. This is in keeping with

Lenon and Mixner (1957) who observed total blood cholesterol values as 96.07 mg per cent in lactating non pregnant cows, and 105.63 mg per cent in heifers. However, Velhanker (1977) noted higher total cholesterol values in all seasons in Gir heifers. Blood et al. (1987) also reported cholesterol values in normal cows as ranging from 39 to 177 mg per cent which is accordance with the present observation and at slight variance with Kumar and Sharma (1991) and Shrivastava et al. (1992) who reported slightly higher mean value but essentially in keeping with the present observation.

Perusal of data presented in the table 5 showed that Hb level (6.86±0.075 g %) of animals with impaired fertility was significantly lower (P <0.10) than that of animals with normal fertility (10.06g %). Morrow (1980) also recorded that animals having lower than 9.91 g per cent Hb level had poor fertility. Pillai (1980) observed mean Hb level of 9.16 g per cent in anoestrus cows. Lower Hb values were also observed in buffaloes with lower fertility by Gangwar et al. (1981). Dhoble and Gupta (1981) and Naidu and Rao (1982) also reported significantly low levels of Hb in anoestrus cows. Sharma et al. (1983) found that Hb level was 9.10±2.5 g per cent and 9.05±2.05 g per cent in anoestrus and repeat breeding cows respectively which was lower than that of normally cycling cows (11.95±1.90 g%)

Kumar *et al*. (1981) also observed similarly. Gujar *et al*. (1990) and Kumar and Sharma (1991) also made similar observations. The present observation that animals with impaired fertility were having significantly lower levels of Hb when compared to that of animals with normal fertility is essentially in keeping with the reports of earlier workers.

The mean PCV obtained in animals with impaired fertility was 21.50$\pm$0.50 per cent (Table 5). This was lower than that of normal levels reported by Blood *et al*. (1987). Low PCV values were recorded in animals with impaired fertility by other workers also. Rao *et al*. (1981) observed lower values for PCV in repeat breeding cows. Similar observation was also made by Sharma *et al*. (1983), Gangwar *et al*. (1984) and Kumar *et al*. (1985, 1986a) in anoestrus and repeat breeding cows compared to normal cycling cows.

The mean phosphours level obtained in animals with impaired fertility was 3.65$\pm$0.068 mg per cent against 4.85$\pm$0.343 observed in animals with normal fertility (Table 5). The difference in the serum phosphorus level between the two groups of animals was significant ($P < 0.10$).

Lower phosphorus values have been reported in animals with impaired fertility by earlier workers also (Ford, 1972, Bodai, 1976, Kiatoko *et al*., 1978, Agarwal *et al*., 1982).

Acharya (1968) observed that lack of phosphorus upsets the proper functioning of reproductive organs. Morrow (1977) also was of the view that low level of phosphorus was one of the causes for oestrus becoming non fertile possibly due to ovulation defects. Bhaskaran and Khan (1981) also remarked that marginal deficiency of phosphorus is sufficient to cause disturbances in pituitary ovarian axis leading to reproductive disorders. The present observation of low level of serum phosphorus in animals with impaired fertility can be attributed to the low intake of phosphorus as suggested by earlier workers, leading to reproductive disorders.

The data on total serum protein of cows with impaired fertility are presented in table 5. It may be observed from the table that level of serum protein in animals with impaired fertility was 4.97 ± 0.30 as against 7.00 ± 0.99 in cows with normal fertility. Statistical analysis revealed significant difference between the two values ($P < 0.10$).

Hewet (1972) suggested that there existed a positive relationship between levels of serum protein and fertility. Patil (1976) observed a significantly low serum protein value in anoestrus cows than in animals exhibited normal postpartum oestrum. This is in concurrence with the earlier reports of Larson and Hendel (1957) and Humana and Ushi (1973). Deshpande et al. (1978) also confirmed this. Pillai (1980), Reheem (1982) and Naidu and Rao(1982) in their detailed investigations have also confirmed that total serum protein levels were significantly lower in problem cows than in normal cows. In an earlier investigation, Alexander (1983) in the same herd, under similar conditions observed that serum protein levels were significantly influenced by higher levels of nutrition. The present observation that the animals with low fertility exhibited low serum protein could be attributed to the poor nutritional status of the animals as reported by earlier workers.

The blood glucose level as presented in Table 5 revealed that cows with impaired fertility had a lower blood glucose level of 31.13$\pm$0.726 mg per cent as against 46.10$\pm$3.19 mg per cent in animals with normal fertility. The composition of diet has a significant influence on the level of blood glucose. MacClure (1968b) associated lower blood glucose with reduced fertility. Patil (1976) observed that level of blood glucose is an index for prediction of oestrum in dairy cows. He also observed a steady decrease in the level of blood glucose in anoestrus cows. Velhanker (1977) also demonstrated higher level of blood glucose in cows with better nutrition. The present observation of lower blood glucose values is therefore in concurrence with the earlier reports as well as with Alexander (1983) and Naveen (1983) who have also reported similar observation in the same herd.

There are several reports indicating that animals in higher plane of nutrition had better reproductive performance (Axelson and Morley, 1976; Mathai and Raja, 1976; Velhanker, 1977b). Downe and Gelman (1976) reported that when the level of plasma glucose was falling fertility was low. Since the composition of diet has a significant influence on the blood glucose level it may be presumed that the low level of glucose presently observed in animals with low fertility could be attributed to the low nutritional intake. The experimental animals selected were also apparently deficient in nutrition.

The level of total serum cholesterol as presented in Table 5 in animals with impaired fertility is 71.36 ± 1.66 mg per cent whereas the level in animals with normal fertility is 95.09 ± 8.67 mg per cent. Statistical analysis revealed significant difference between the two values($P<0.10$). Blood cholesterol level was reported to have good correlation with fertility (Bhattacharya, 1972; Velhanker, 1978 b; Pedroso, 1980; Kampl, 1990). Deopurkar (1974), Jadhav (1975) and Murtusa <u>et al</u>. (1978) observed that anoestrus cows had lower cholesterol values than normal cycling cows. Pareek and Aminudeen (1985) in a study in Rathi cows observed cholesterol levels in anoestrus cows as 181.61 mg per cent which was significantly lower than normally reproducing cows (273.33 mg %). Although these values are higher than the values currently observed in the group of animals studied, the difference could be attributed to the difference in the herd, feeding practices and management. However, the present observation is in agreement with the above in that, that the animals with lower fertility exhibited lower cholesterol values than animals with normal fertility. Shrivastava and Kharche (1986) and Kumar and Sharma (1991) have also made similar observations.

The overall conception rate of animals with normal fertility and animals with impaired fertility is presented in table 6. The conception rate in animals with impaired fertility is only 11.11 per cent as against 81.80 per cent in animals with normal fertility. Nutritional deficiencies and imbalances have been reported to be major causes for fertility failures in cattle (McClure, 1965a, 1968 a Boyd, 1970, Velhanker, 1977b, Deshpande et al. 1978).

Deficiency of protein, carbohydrate, phosphorus, cobalt, copper, iodine, etc. as causes of impaired fertility have been reported earlier (Morrow, 1980; Arthur, 1989). It is an accepted fact that animals on higher plane of nutrition have better conception rate. Reports of Downie and Gelman (1976) and Leaver (1977) confirmed the earlier views that animals on higher plane of nutrition had higher pregnancy rates. According to Deshpande (1979), Patil and Deshpande (1979) and Morrow (1980) when the plane of nutrition of dairy cows were raised higher, the conception rate also increased, suggesting that lowered nutritional level had a deleterious effect on conception rate on cows. In the present study animals with impaired fertility were apparently nutritionally deficient and also low in various blood parameters.

The conception rate of cows with normal and low level of different haematological and blood biochemical constituents are furnished in table 7. It may be observed from the table that the animals with normal Hb, the conception rate averaged 50 per cent whereas none of the animals with low Hb conceived. Similarly when 45.75 per cent animals with normal PCV conceived, none of the animals with low PCV became pregnant. There are several reports to indicate direct correlation between blood cellular changes and fertility in cattle (Rowlands et al., 1957; Adams, 1969 and Wagner, 1972). Lower Hb levels has been associated with anoestrus and repeat breeding problems in cows. Morrow (1977) observed higher fertility in cows with higher level of Hb. Rao et al. (1982), Naidu and Rao (1982), Sharma et al. (1983), Gangwar et al. (1985), Kumar et al. (1985) have also recorded higher haematological values in normal cows than in problem cows. Alexander (1983) in his detailed study also recorded higher Hb in cows with normal reproductive status. Prasad et al. (1984) also opined that Hb and certain biochemical constituents in blood affected fertility in dairy cows. Kumar etal. (1985) have also recorded higher haematological values in normal cows than in problem cows. The poor conception rate observed in the problem animals in the present study point to a lowered nutritional level resulting in poor haematological values also.

In cows with normal serum phosphorus, the conception rate observed is 71.40 per cent whereas the same in problem animals is 8.30 per cent (Table 7). Analysis of the data revealed significant variations between the two groups ($P<0.01$). Hignet and Hignet (1951) and Hignet (1960) have recorded reproductive failures and ovarian dysfunction at low phosphorus level. Acharya (1961) opined that lack of phosphorus upset the proper functioning of reproductive organs. Morris (1976) and Morrow (1977) have also substantiated the above statements and recorded lower reproductive levels in animals with low phosphorus level. A positive correlation between disturbance of oestrous cycle and phosphorus deficiency was also reported by Shrivastava et al. (1982). The low conception rate currently observed concur with the above findings. It could also be attributed that marginal deficiency of phosphorus causes disturbances in pituitary ovarian axis as suggested by Bhaskaran and Khan (1981). Pedroso et al. (1986) had also observed significant influence of blood phosphorus status in fertility in crossbred animals. This view can also be attributed to the low fertility level in the experimental animals. Jaskowski (1986), Muffarrege et al. (1986), Ropstad et al. (1988), Simeonov et al. (1989) and Pandey et al. (1991) have also recorded low conception rate in animals with low phosphorus level. The present findings confirm the earlier reports.

The conception rate in cows with normal serum protein levels is 46.70 per cent while that in animals with low level is 40.70 per cent. Although, not statistically significant, the conception rate observed in animals with low level of protein is lower than those of animals with normal protein level. Several workers have suggested that reproduction in dairy cows was significantly influenced by the level of protein in the ration (Gould, 1969, Sonderegger and Schurch, 1977; Jordan and Swenson, 1979; Morrow, 1980). According to Hewet (1972) there existed a positive relationship between levels of serum protein and fertility. Larson and Kendal (1957) and Humana and Ushi (1973) also found lower levels of serum protein in problem cows than cows with normal fertility, although, the difference was not significant which is in agreement with the present observation. Deshpande et al. (1979) opined that the values of serum protein in cows with impaired fertility never reached the level of normal fertile cows. This finding was later corroborated by Pillai (1980), Reheem (1982), Naidu and Rao (1982), Aminudeen and Pareek (1984).

The data regarding conception rate of cows with normal serum glucose level and low blood glucose level are presented in table 7. While animals with normal serum glucose revealed a conception rate of 70 per cent the same was only 7.69 per cent in the other group. This difference was statistically highly significant ($P<0.01$). McClure (1965a) observed a fertility rate of 77 per cent in animals having blood glucose level of 48 mg per cent and a conception rate of zero in animals having blood glucose level of 25 mg per cent or less. McClure (1968 b) found that blood glucose level below 30 mg per cent was associated with reduced fertility. According to Reheem (1982) cows with normally functioning ovaries possessed higher levels of blood glucose than with completely inactive ovaries. Alexander (1983) and Naveen (1983) have also recorded similar observations. Kappel et al. (1984) and Anderson and Emanuelson (1985) have also recorded correlation between glucose level and fertility in dairy cows. The present observation that animals with higher blood glucose levels had better conception rate is essentially in keeping with the earlier observations in this regard.

Deshpande et al. (1978) had suggested that estimation of blood glucose and total protein can be used as a tool to differentiate whether the cow after calving can be a normal breeder or not. The present observation also point to this.

The conception rate of cows with normal level of cholesterol and cows with low level of cholesterol were 69.20 per cent and 13.33 per cent respectively. Statistical analysis revealed significant difference in conception rate between these two groups. According to Bhattacharya et al. (1972), Velhanker (1977), Pedroso (1986) and Kampal et al. (1990) blood cholesterol was reported to have good correlation with fertility in dairy cows. Velhanker (1978) reported that animals with higher value of serum cholesterol exhibited better and consistent reproductive performance. In accordance with the observation of Deopurkar (1974), Jadhav et al. (1977), Murtuza et al. (1978), Aminudeen et al. (1984), and Survaiya et al. (1991) anoestrus cows had low cholesterol level than normally cycling animals. Since the blood level of cholesterol is an indication of the beneficial effect of dietary supplementation of energy, better reproductive performance could be attributed to better nutritional status of the animals. The present findings therefore support the findings of Aroj et al. (1968), Velhanker (1977) and Kumar and Sharma (1991) in this regard.

The overall conception rate of animals with impaired fertility and treated for certain deficient blood parameters was 77.77 per cent (Table 8) as against 11.11 per cent in untreated animals. Although protein, vitamins and mineral deficiencies are capable of producing poor fertility, the mean effect is that of deficient energy intake (Leaver, 1977). Animals, that are poor or of moderate conditions of nutritional status, improved in conception rates when dietary intake was increased. In the present study, animals with lower impaired fertility and apparently deficient in nutrition were administered glucose and phosphorus. Downie and Gelman (1976) observed that even when body weight was falling and blood glucose was rising fertility was good. The significant enhancement of conception rate observed in the animals under treatment could be considered as the beneficial effect of administration of deficient parameters.

The conception rate of animals treated with phosphorus alone is presented in table 9. A conception rate of 71.42

per cent was observed in animals treated with phosphorus whereas in untreated animals it was only 25 per cent. Beneficial effects of administration of phosphorus have been reported by many authors (Sattar, 1973; Deshpande et al., 1978, Samad et al., 1980 and Morrow 1980). The deficiency can be corrected by special feed or by therapeutic measures. In Gir cows, Kulkarni (1973) found significant beneficial effects with administration of Tonophosphan. Scharp (1979) opined that with the level of serum phosphorus increasing with the addition of superphosphate in the ration, a concomitant increase in pregnancy rate from 36.5 per cent to 63.2 per cent was also observed. In the present study the fertility increased from 25 per cent to 71.42 per cent with treatment of phosphorus alone. This confirms the earlier beneficial observations cited and also that of Singh et al. (1978), Bodai et al. (1984) Singal et al. (1988) and Behera et al. (1993).

In the animals deficient in glucose and treated with intravenous administration of glucose, the conception rate was 75 per cent whereas in the untreated group it was only 12.5 per cent. The difference in the conception rate could be attributed to the beneficial effects of glucose administration before insemination. Roberts (1971) suggested that hypoglycaemia at oestrum or shortly after service may exert a harmful effect on conception by lowering the glucose and glycogen level in the mucosa of genital tract resulting in lack of energy to spermatozoa or fertilised ova. It can be surmised that the therapy might have increased the level of glucose in the luminal fluids so that nourishment and life of fertilized ova in the uterus before implantation is improved increasing the conception rate.

Beneficial effects of glucose therapy have been recorded earlier. In repeater cows, Goroh (1962) obtained 100 per cent conception rate with irrigation of uterus and cervix with sugar solution. Mathew et al. (1980) and Naveen (1983) have also concurred with the above. Naveen (1983) also stated that with higher glucose level conception rate increased significantly. The higher conception rate currently observed in the treated group could, therefore, be attributed to the possible beneficial effects of glucose confirming the earlier reports.

The data on the conception rate of animals treated with both glucose and phosphorus are presented in Table 11. Out of 8 animals treated 7 conceived giving a conception rate of 87.5 per cent whereas none of the untreated animals conceived. This difference was highly significant($P < 0.01$).

The difference in conception rate could possibly be attributed to the beneficial effects on the administration of glucose and phosphorus, since these animals were apparently deficient in both these parameters based on assessment by haematological and biochemical studies. Leathem (1966) reported that undernutrition could reduce secretion of gonadotrophins from pituitary glands in most species. Besides, inadequate diet could depress ovarian function also (King, 1971). Deficiency of protein, carbohydrate and phosphorus as causes of impaired fertility have been reported earlier (Roberts 1971; Morrow, 1980; Arthur, 1989). Downie and Gelman (1976) observed that when the blood glucose level was rising fertility was good. Similarly Leaver (1977) and Velhanker (1977) also reported that when the plane of nutrition of dairy cows was enhanced pregnancy rate also improved. In the present experiment, the administration of glucose and phosphorus could have improved the serum status of these animals thereby conferring the benefits of better nutrition for higher fertility.

From the foregoing paragraphs, it is evident that the cows with normal fertility had haematological and blood biochemical parameters like Hb, PCV, Phosphorus, protein, glucose and total cholesterol within the normal limits. In the group II animals with impaired fertility the level of

Hb, PCV, phosphorus, protein, glucose and cholesterol were below the normal limits thereby suggesting a positive relationship between these factors and fertility. The overall conception rate in animals with normal blood parameters averaged 81.80 per cent while the same in animals with impaired fertility was only 11.11 per cent exhibiting the deleterious effect of low nutritional status. Similarly while the conception rates in animals deficient in Hb, PCV, protein, phosphorus, glucose and cholesterol were 0, 0, 40.7, 8.13, 7.69 and 13.33 per cent respectively, the same in animals with normal parameters were 50, 40.75, 46.7, 71.40, 70.00 and 69.20 respectively. However in animals treated with phosphorus, glucose or in combination, the conception rate improved to a level of 71.42, 75.00 and 87.5 per cent respectively.

The significant difference observed in the conception rate between the animals with normal and deficient parameters on the one hand and deficient and treated animals on the other hand point to a significant influence of these constituents in the fertility of cows. Afterall reproduction is a luxury function by animals and any deficiency not only delays onset of oestrum but also reduces fertility. The results of the present study point to an influence of these parameters on the reproductive status of dairy cows. It could therefore be surmised that assessment of certain blood parameters would serve as an ideal tool in predicting the fertility status of the animals. However, it is recommended that based on the present finding a wider investigation involving more animals under varied managemental and nutritional status is warranted before reaching a final conclusion.

Summary

SUMMARY

The aim of the present investigation was to study the influence of certain haematological and blood biochemical parameters on fertility in crossbred cows. A detailed investigation was undertaken in cows with normal and impaired fertility Animals which had apparently normal breeding history and conceived with one or two inseminations were classified as normal and animals that were hard to settle and apparently deficient in nutrition but clinically free from any genital affections were classified as those with impaired fertility. Crossbred cows brought for insemination at the Artificial Insemination Centre, Mannuthy and University Livestock Farm, Mannuthy formed the material for the study.

The breeding history and feeding practices of all these animals were collected in detail and were subjected to detailed gynaeco-clinical examination and divided primarily into two groups. Eleven animals with normal fertility were included in group I. Fifty two animals which were of impaired fertility were included in group II.

Blood samples were collected from all these animals at oestrus and levels of haemoglobin (Hb), packed cell volume (PCV), serum total protein, serum phosphorus, blood glucose and total blood cholesterol were estimated. After

estimation of blood constituents the cows in group II were divided into two. Animals in group IIA were inseminated without any treatment and animals in group II B were administered 15 ml Tonophosphan by intravenous injection, or 540 ml of 25 per cent dextrose as intravenous infusion or both; based on whether the animals were deficient in phosphorus or glucose alone or in combination and those animals were also inseminated and followed up. The data of all these animals were collected and analysed statistically.

Estimation of the haematological and blood biochemical constituents revealed that in animals with normal fertility the levels of Hb, PCV, serum Phosphorus, blood glucose, total serum protein and total serum cholesterol were 10.06±0.6 g per cent, 31.±1.33 per cent, 4.85±0.343 mg per cent, 46.10±3.19 mg per cent, 7.00±0.99 g per cent and 95.09±8.67 mg per cent respectively. The overall corresponding values for animals with impaired fertility were 8.085 g per cent, 28.52 per cent, 4.175 mg per cent, 47.27 mg per cent, 6.91 mg per cent and 93.35 mg per cent respectively.

In cows in group II with deficiency of different constituents, the mean levels of Hb, PCV, serum phosphorus, blood glucose, total serum protein and total cholesterol were 6.86±0.75, 21.50±0.50, 3.65±0.068, 31.13±0.726, 4.57±0.30 and 71.36±1.66 mg per cent respectively. All these levels were significantly lower than their corresponding levels in normally fertile animals ($P<0.10$).

The overall conception rate of animals with normal fertility was 81.80 per cent whereas the same in animals with impaired fertility without treatment (Group II A) was 11.11 per cent.

Conception rate of cows with lower level of Hb was zero which was significantly lower than the conception rate of 50 per cent observed in animals with normal level of Hb ($P<0.05$). Similarly conception rate of cows with low level of PCV was also zero compared to 40.75 per cent in animals with normal level of PCV.

Animals with lower levels of biochemical parameters also exhibited conception rate lower than normal animals. While cows with low level of serum protein and serum phosphorous had only conception rates of 40.70 and 8.30 per cent as against 46.70 and 71.40 per cent in animals with normal levels. Statistical analysis revealed significant difference in conception in animals low in serum phosphorus ($P < 0.01$) Similarly cows with low levels of blood glucose and cholesterol also had low fertility. The rates recorded in these animals were only 7.69 and 13.33 per cent as against 70.00 and 69.20 per cent in normal animals. The difference observed in these groups were also statistically highly significant (P <0.01).

Overall level of conception rate of animals with impaired fertility (Group II B) after treatment was 77.77 per cent.

In animals deficient in phosphorus and treated with Tonophosphan 71.42 per cent became pregnant. But only 25 per cent of animals conceived without any treatment.

In animals with deficiency of glucose but treated with intravenous infusion of glucose the conception rate was 75 per cent. However in animals without any treatment it was only 12.50 per cent.

In cows with combined deficiency of phosphorus and glucose but treated for both, the conception rate was 87.5 per cent whereas it was zero in non treated groups. This difference was highly significant (P<0.01).

It could thus be concluded that levels of certain haematological and biochemical parameters have definite influence on the fertility in cows. The conception rate also increased with treatment of deficient parameters. However the assessment of these parameters as an index of impending fertility in dairy cows would need further detailed study based on larger number of animals.

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CERTAIN HAEMATOLOGICAL PARAMETERS AND BLOOD BIOCHEMICAL CONSTITUENTS IN COWS WITH NORMAL AND IMPAIRED FERTILITY

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ABSTRACT

A study was conducted to asses the influence of certain haematological parameters like haemoglobin (Hb) and packed cell volume (PCV) and biochemical constituents like total serum protein, serum phosphorus, total blood cholesterol and blood glucose in crossbred cows and the efficacy of replacement therapy of glucose and phosphorus on fertility in deficient animals.

Animals which had apparently normal breeding history and conceived with one or two inseminations were classified into group I. Animals that were hard to settle and apparently deficient in nutrition but clinically free from any genital affections were classified into group II. Blood samples were collected from all these animals at oestrus and levels of Hb, PCV, serum total protein, serum phosphorus, blood glucose and total blood cholesterol were estimated. After estimation of blood constituents the cows in group II were divided into two. Animals in group II A were inseminated without any treatment and animals in group II B were administered 15 ml of Tonophosphan by intravenous injection or 540 ml of 25 per cent dextrose as intravenous infusion or both based on the deficiency of phosphorus or glucose alone or in combination.

The levels of Hb, PCV, serum phosphorus, blood glucose, total serum protein and total serum cholesterol were

10.06±0.06 g per cent, 31±1.33 per cent, 4.85±0.343 mg per cent, 46.10±3.19 mg per cent and 7.00±0.99 g per cent and 95.09±8.67 mg per cent respectively in normally fertile cows. In cows with impaired fertility which were deficient in different constituents the corresponding levels were 6.86±0.75 g per cent, 21.50±0.50 per cent, 3.65±0.068 mg per cent, 31.13±0.726 mg per cent, 4.57±0.30 g per cent and 71.36±1.66 mg per cent respectively, all of which were significantly lower than their corresponding levels in normally fertile cows (P <0.10).

The overall conception rate was 81.80 per cent 11.11 per cent and 77.77 per cent in group I, group IIA and II B cows. Conception rate of cows with lower levels of Hb (zero) was significantly lower than the conception rate (50 %) observed in animals with normal level of Hb (P <0.05). Similarly the same in cows with normal and low levels of PCV was 40.75 per cent and zero respectively. Cows with low levels of serum protein and serum phosphorus had conception rate of 40.70 per cent and 8.30 per cent against 46.70 per and 71.40 per cent in animals with normal values. Statistical analysis revealed significant difference in the case of phosphorus (P<0.01). Similarly cows with low levels of blood glucose and total cholesterol also had significantly low ($P<0.01$) conception rates (7.69 and 13.33% respectively) as against that in normal cows (70 and 69.20%).

Animals when treated with phosphorus alone 71.42 per cent conceived as against 25 per cent in non treated group. Similarly 75 per cent of animals conceived when treated with glucose compared to 12.5 per cent conception rate in non treated group. When cows were given combined treatment of glucose and phosphorus conception rate was 87.5 per cent while none conceived in non treated group. This difference was statistically highly significant ($P<0.01$).