STUDIES ON SOME ASPECTS OF PICA IN BUFFALOES AND CATTLE

By

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CERTIFICATE I

This is to certify that this thesis entitled, "Studies on some aspects of pica in buffaloes and cattle" submitted for the degree of M.V.Sc. in the subject of Veterinary Medicine of the Chaudhary Charan Singh Haryana Agricultural University, is a bonafide research work carried out by Dr.Jagdeep Singh Yadav under my supervision and that no part of this thesis has been submitted for any other degree.

The assistance and help received during the course of investigation have been fully acknowledged.

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CERTIFICATE II

This is to certify that this thesis entitled, "Studies on some aspects of pica in buffaloes and cattle" submitted by Dr. Jagdeep Singh Yadav to the Chaudhary Charan Singh Haryana Agricultural University in partial fulfilment of the requirements for the degree of M.V.Sc., in the subject of Veterinary Medicine, has been approved by the Student's Advisory Committee after an oral examination on the same, in collaboration with an External Examiner.

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C O N T E N T S

I N T R O D U C T I O N

INTRODUCTION

Pica or mud eating is quite common in different species of animals throughout the world (Blood et al., 1989). It has been a serious problem amongst camels for the last many years leading to high mortality. These days many cases of acute pica in buffaloes and cattle are being reported from different parts of Haryana (Bansal, 1993).

Pica or allotriophagia is a depraved appetite in which the animal craves eagerly for substances not ordinarily consumed as food/feed and as such, the moment the animal gets a chance it starts licking, eating or drinking voraciously the abnormal material. It may occur in some cases due to deficiency in diet either of bulk or fibrous material, minerals and vitamins. Pica may also be associated with conditions like gingivitis due to teething, gastritis, parasitic diseases and rabies. Insufficient housing space, close confinement and little or no exercise, in other words, ill management results in the development of pica.

The abnormal materials ingested by different species like camel, buffalo, cattle, horse, donkey, sheep, goats and dogs are large lumps of mud from ponds, kachcha walls, earth

from ploughed fields (upto several kilograms), stones, bricks, sand, cloth, leather, iron/metal, bones, hair, wood, glass, faeces and even drink their own urine. The choice for ingestion of abnormal material may vary in different species of animals depending upon the easy availability of that material.

It has been observed in buffaloes and cattle that they take large quantities of earth/mud, leather, clothes and even paper. Buffaloes jump into the ponds or run towards kachcha walls and start devouring mud.

Blood et al. (1989) described pica as a condition in which animal takes abnormal food materials.

On the basis of materials ingested, pica may be defined as follows :

Osteophagia	- chewing of bones
Infantophagia	- eating of young ones
Coprophagia	- eating of faeces
Trichophagia	- eating of wool
Cannibalism	- eating of ones own type
Bark eating	- eating the bark of tree
Carrion eating	- eating rotten material
Leather chewing	- chewing tanned skin of animals
Geophagia	- earth/mud eating

Pica in affected animals may have serious consequences such as botulism, lead poisoning, foreign body syndrome,

perforation of oesophagus or stomach and accumulation of wool, fibre or sand may cause obstruction.

In recent years the number of cases of pica in buffaloes and cattle caused great economic losses in the form of reduced milk yield, inappetance, prolapse of vagina and abortion. Recently, it has been reported by a farmer of village Alupur (Fatehabad) that one out of his ten buffaloes died due to acute pica (Bansal, 1993).

No systematic investigations have been undertaken on this emerging problem of buffaloes and cattle which may cause hinderance to programmes of white revolution.

Taking into consideration the importance of this emerging field oriented problem and meagre availability of literature it was planned to investigate the problem of pica in bufffaloes and cattle with the following objectives :

1) To study haematological and biochemical changes in pica affected buffaloes and cattle.
2) To investigate and identify the parasites, if any, in pica affected buffaloes and cattle.
3) To treat and study the chemotherapeutic effects of Ivermectin and Albendazole and supportive treatment depending upon the etiology of pica in buffalo and cattle.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

No detailed reports of pica in buffaloes seem to be available in literature and information on pica in cattle is meagre. However, there are some reports available on pica in camels, horses, sheep, pigs, dogs, poultry and man. The information available is detailed below :

Buffalo

Bansal (1993) mentioned in his annual report of the scheme "Investigations on Diseases of Camels" that during 1992-93, 109 cases of pica in buffaloes (24 males and 85 females) were reported from Haryana and cured successfully by fenbendazole @5 mg/kg body weight orally with supportive treatment.

Cattle

Runnels et al. (1965) described that cattle develop depraved appetite because of mineral deficiency and chewed bones, sticks, stones and other objects to obtain phosphorus. When a phosphorus deficiency is suspected, a method for testing is applied. An extremely phosphorus deficient animal will even lick and chew the decaying bones.

Correa et al. (1971) observed pica in calves which were fed diet deficient in cobalt.

Robert et al. (1975) studied a herd of 45 cattle suffering from polyuria with other signs of salt hunger, pica, weight loss and decreased milk production. Their analyses indicated a primary sodium deficiency which responded to sodium chloride when provided ad libitum. These cows on salt deficient diets developed salt hunger and pica after two or three weeks which included signs of licking concrete mangers, metal pipes, farmer's clothing as well as dirt and rocks in the barnyard. Some cows preferred straw bedding to good quality alfalfa hay.

After several months the homeostatic mechanisms of lactating cattle could no longer compensate for the massive sodium loss into the milk. At this juncture appetite, milk production, body weight and general condition decreased rapidly. Death would have occurred had not salt been given.

Fettman et al. (1984) observed that cows on low chloride diet licked other cow's urine, eating bedding material, chewing on wooden stall dividers and licking metal pipes in the manger to the point that crescent shaped areas devoid of rust developed. Additionally a few of these cows temporarily acquired a bluish green staining of their muzzles from licking the copper sulfate foot bath outside the milking parlour.

They summarized the metabolic alterations as severe primary hypochloremic and secondary hypokalemic metabolic alkalosis.

Bansal and Jain (1993) reported an acute case of pica in a crossbred cow which ate only soil. The animal had become very weak and emaciated, and had also developed tendency to bite human beings and tail of other fellow animals. The faecal examination revealed heavy strongyle infection. The cow did not respond to albendazole @ 5 mg/kg body weight orally and mineral mixture @ 100 grams daily for three days, but got cured successfully when mifex @ 450 ml was administered intravenously.

Camel

Bansal et al. (1968) reported that eating of mud and earth by camels is a menace leading to heavy death tolls. They stated that it is a wasting disease of chronic nature characterized by depraved appetite, severe anaemia and loss of condition in spite of good feeding, ultimately leading to death. Banminth (Pyrantel tartrate) was highly efficacious for treating clinical cases.

Bansal et al. (1971) further investigated many cases of pica in camels infected with worms Trichostrongylus, Haemonchus, Trichuris, Oesophagostomum, Strongyloides and Nematodirus species. They found significantly low haemoglobin

($P<0.01$), total erythrocytic count ($P<0.01$) and packed cell volume ($P<0.01$) and hypochromic normocytic anaemia. There were low serum calcium (6.68 ± 0.86 mg/dl) and inorganic phosphorus (4.59 ± 1.23 mg/dl) ($P<0.05$). Bansal et al. (1979, 1981, 1988 and 1989) successfully trated camels suffering from pica having gastro-intestinal nematodiasis with thiabendazole (@ 66 mg), fenbendazole (@ 5 mg), morental citrate (@ 5 mg) and albendazole (@ 5 mg)/kg body weight orally, respectively. Singh et al. (1986) reported microcytic hypochromic anaemia in camels suffering from pica and found significantly low levels of serum phosphorus and iron, whereas sodium, potassium and calcium values were within the normal range.

Horse

Miller and Robertson (1959) reported that the habbit of gnawing and licking in horses may be due to inadequate feed, some gastrointestinal worms, boredom and confinement.

Dalling (1966) mentioned that to get vitamins of B complex group coprophagia is seen in horses, as unlike ruminants they cannot synthesize vitamins of B complex group.

Schurg et al. (1977) observed that the adult horses maintained on a protein deficient diet exhibited coprophagy which was eliminated when a dietary supplement which increased dietary protein to 10 per cent crude protein was fed.

Ralston et al. (1979) reported that wood chewing by horses is a widely recognized phenomenon and has been ascribed to a number of factors ranging from boredom to dietary deficiency.

Keenan (1986) reported that the difference of more than half the fibre content in natural and irrigated pastures may induce a craving for fibre by the hroses when fed on irrigated pasture and result in increased bark chewing.

Sheep

Hutyra et al. (1949) first reported pica in sheep in Alps areas. These sheep had a peculiar habbit of eating sweat soaked socks of travellers which was attributed to salt deficiency. The authors explained that shortage of alkali metals in herbivorous animals caused incomplete neutralization of acid products and licking sickness resulted in pica.

Bansal (1990) reported acute pica in a herd of 143 sheep (108 adults and 35 kids), which had become very weak and emaciated and were taking lot of earth from ploughed fields. These sheep were treated successfully with albendazole @ 5 mg/kg body weight orally and supportive treatment.

Dogs

Hoskins et al. (1959) stated that some malnourished dogs developed vices like eating of earth, sand gravels, bones and

other materials. Boredom and confinement undoubtedly contributed to coprophagia, hookworm infection or other parasitic infestations or vices.

Dalling (1966) stated that coprophagia and infantophagia were the most common sequelae of pica in bitches.

Gupta et al. (1993) reported that a spitz female dog aged about four years having depraved appetite accidentally ingested zinc phosphoide and was treated successfully by sodium benzoate 50 mg in 2 ml distilled water intra muscularly along with symptomatic treatment.

Poultry

Schwarte (1965) observed that feather picking in poultry was mainly due to the lack of animal proteins in the diet and insufficient housing. he opined that new litter may also cause pica in poultry.

Dalling (1966) stated that the poultry deprived of its litter becomes deficient in vitamin D and K and coprophagia is observed. Hens deficient in protein can also develop pica. Egg eating is the most common sequelae of pica in poultry.

Man

Wohl and Goodhart (1968) observed that there were number of disorders of appetite, the best known is the distorted appetite of women during pregnancy called pica.

Koptagel and Reimann (1973) studied the psychopathology of pica in children. They described pica in detail with special reference to hypochromic anaemia. Sayers et al. (1974) discovered a relationship between pica and iron deficiency in black adults in Johannesburg.

Karayalein and Lanzboursky (1976) related pica with zinc deficiency and suggested zinc inclusions in the diet to prevent or treat it in human beings.

In addition to the earlier mentioned species specific reports, some general reports on pica in animals are detailed as under :

Dalling (1966) described that pica in animals might be due to nutritional deficiency of salt, cobalt or phosphorus or diseases like peritonitis, gastritis, ketosis, rabies and in boredom. He further mentioned that the greatest danger in animals showing coprophagia is that of parasitism, coccidiosis and botulism.

Maynard and Loosli (1969) reported that phosphorus deficiency specifically caused depraved appetite and led to very heavy losses in the grazing animals even where forage was abundant and nutritionally adequate in all respects. Many of the deaths occurred due to contracting other affections particularly on eating of decaying bones of animals which had died.

Swenson (1970) described rooting in swine, geophagia in cattle, coprophagia in rabbits and primitive feeding habbits in

dogs as some form of pica in these species of animals.

Blood et al. (1989) reported pica to the ingestion of material other than normal food which varied from licking to actual eating or drinking. They stated that it is due in most cases to dietary deficiency either of bulk or in some cases more specifically fibre or of individual nutrients, particularly salt, cobalt or phosphorus. They further mentioned that boredom (in case of animals closely confined) often results in pica. Chronic abdominal pain due to peritonitis or gastritis and central nervous system disturbances including rabies and nervous acetonemia are also causes of pica. In many cases the actual cause of pica cannot be determined and corrective measures may have to be prscribed on the basis of trial and error.

MATERIAL AND METHODS

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i) Experimental animals

The present investigations were made on buffaloes and cattle suffering from pica under field conditions.

The cases of pica recorded were those reported by the owners in the Department of Veterinary Medicine and also those reported by the veterinarians around Hisar and material collected for further studies.

ii) Clinical examination

To diagnose the disease and to study its various aspects, history and clinical examination of each animal were recorded at different stages of the disease, viz., on day zero, 20 and 40 of treatment.

In all 16 clinical cases of buffaloes and 20 cases of cattle were studied and the observations and information were recorded on the proforma detailed below :

Dated _____ Case No._____

Name and address of owner_____

Species of animal _____ Breed _____

Age _____ Sex _____ Weight _____

Identification marks of the animal _____

History of animal :

Total number of animals _____

Number of pica affected animals _____

Abnormal materials eaten _____

Treatment given (if any) _____

Period of illness _____

Present condition of animal _____

Treatment given on day zero _____

Observations and treatment given on day 20 _____

Observations on day 40 _____

iii) Collection of blood samples

Blood samples were collected from the jugular vein on day zero, 20 and 40 of treatment after properly restraining the animal. For haematological studies 5 ml of blood was collected in clean, sterile rubber capped vials containing one mg of ethylene diamine tetra-acetic acid (EDTA) as an anticoagulant.

iv) Haematological studies

Haemoglobin (Hb, gm%), total erythrocytic count (TEC, million/cmm), total leucocytic count (TLC, thousands/cmm), packed cell volume (PCV %), mean corpuscular volume (MCV, cubic microns, cu) and mean corpuscular haemoglobin concentration (MCHC %) were estimated.

The Hb estimation was made by acid hematin method (Schalm et al., 1975) using standard haemometer. For TEC, each blood sample was diluted 1:200 with Hayme's solution in the red blood corpuscle (RBC) diluting pipette. For TLC, each blood sample was diluted 1:20 with 2% acetic acid in distilled water and one ml of gentian violet. The counts for both were made in the counting chamber with improved Neubauer ruling of haemocytometer. The PCV was estimated by the microhaematocrit method. MCV and MCHC were calculated according to the formulae of Schalm et al. (1975).

$$MCV = \frac{PCV}{TEC} \times 10 \text{ cubic microns}$$

$$MCHC = \frac{Hb}{PCV} \times 100 \text{ per cent}$$

v) **Collection of serum samples**

For estimation of sodium, potassium, calcium, phosphorus, magnesium and iron levels, about 10 ml of blood was collected from each pica affected buffalo and cattle separately. Serum was separated and stored at -20°C till used.

vi) **Biochemical studies**

a) **Calcium :** Serum calcium levels were estimated by the auto analyser using autopak reagent kit. Calcium in alkaline

medium reacts with O-cresolphthalein complexone to form an intense chromophore which absorbs light at 570-580 nm. Magnesium and iron are excluded from the reaction by complexing with 8-hydroxyquinoline. One ml of kit reagent and 10 ul of serum were used and reading recorded as mg/100 ml serum.

b) **Inorganic phosphorus :** Inorganic phosphorus levels were estimated as per the methods of Taussky and Shorr (1953). The blue colour developed by treating deproteinated serum sample with ferrous sulfate molybidate reagent is directly proportional to the amount of phosphorus in the serum samples.

c) **Magnesium :** Magnesium level in serum was determined photometrically by the modified Neill and Neely (1956) method. Tungstic acid filterate of serum forms a red lake with titan yellow in alkaline solution. Colour formation is potentiated by polyvinyl alcohol which is proportional to the magnesium levels in serum.

d) **Iron :** The serum iron levels were estimated by use of atomic absorber after deproteinizing serum with nitric and trichloroacetic acid and heating to 90°C for half an hour. Reading is taken at 248 nm wave length.

e) **Sodium :** The serum sodium levels were estimated by flame photometry method as described by Oser (1965). Standard

sodium solutions were prepared using Analar grade sodium chloride salts in triple glass distilled water. Samples were diluted 1:100 and values of sodium read directly from the digital flame photometer reader and expressed as mEq/litre of serum.

f) **Potassium :** The serum potassium levels were estimated by the method similar to sodium as detailed above.

vii) **Treatment**

Eight buffaloes and 10 cattle were treated with Velbazene (Albendazole 5% w/w, SKF Mysore) @ 5 mg/kg body weight orally, eight buffaloes and 10 cattle with Ivomec (Ivermectin 1% w/v, Dynamic Pharma Pvt. Ltd., Bombay) @ 1 ml/ 50 kg body weight subcutaneously. Supportive treatment with calfos AD_3 + mineral mixture or with specific mineral was also given as per the needs of the animal indicated through serum biochemical estimation.

viii) **Collection of faecal samples**

Faecal samples were collected from the rectum of the animals in clean screw capped plastic vials without any preservative.

The egg per gram (EPG) of faeces was done by Stoll's technique (Soulsby, 1968). Three grams of faecal material was added to N/10 NaOH to make it 45 ml in a graduated cylinder.

After shaking, 0.15 ml of the homogenous suspension was placed on a slide covered with the cover slip. The total number of eggs were then counted. This number multiplied by 100, gave the number of eggs per gram of faeces. A portion of the faecal sample from each animal was moistened and kept covered in a petri dish at room temperature for seven to ten days for egg culture. The larvae hatching from the ova were separated by Baermann's technique for micrometery (Soulsby, 1965, 1968) and the species of strongyle parasites identified as per standard micrometric values of Georgy and Georgy (1990).

The efficacy of albendazole and ivermectin was calculated by the formulae of Bauer and Hafner (1990) as given below :

$$\text{Efficacy} = \frac{(\text{Mean EPG pre treatment} - \text{Mean EPG post treatment})}{\text{Mean EPG pre treatment}} \times 100$$

R E S U L T S

RESULTS

In the present study pica was recorded in 16 buffaloes and 20 cattle of Hisar and villages around Hisar. The disease affected animals of both the sexes and of all age groups. Animals suffering from this disease had the history of eating large lumps of mud and earth from ploughed fields, ponds, walls of kuchcha houses, pieces of pakka bricks, stones, bones, leather, shoes, metallic pieces and even glass pieces. Such untreated buffaloes and cattle ultimately became very weak and emaciated and produced less milk.

The cases were generally seen where animals were poorly housed and malnourished or were heavy milk yielders. The scarcity of food and fodder was mainly due to poor economic condition of the farmers.

From table 1 it is evident that out of total 16 buffaloes (2 males and 14 females) examined and treated, three were of age less than one year, eight were between one to three years, two were between three to five years, two were between five to seven years and one was more than seven years.

From table 2 it is evident that out of 20 cattle (9 males and 11 females) examined and treated four were of age less than one year, four were between one to three years, five

Table 1. Showing sex, age and history of different cases of pica affected buffaloes

Sr.No.	Place	Sex	Age	History
1.	Piran-wali	Male	2 months	Was eating chikni mitti (Slury mud) and licking walls for last 20 days.
2.	Hisar	Male	5 months	Was licking mud for the last 2 months and was dewormed when 15 days.
3.	Piran-wali	Female	6 months	Was licking and eating mud where it and other animals urinated for the last 1½ months, hair coat was rough.
4.	Arya Nagar	Female	1 year	Passed hard faeces and was eating soil, rope and puur for the last 2 months.
5.	Piran-wali	Female	1 year	Was eating bajri and small pebbles left after seiving for the last 20 days. Faeces were diarrhoeic.
6.	Arya Nagar	Female	1½ years	Was eating soil, rope and puur for the last 2 months. Faeces were hard.
7.	Arya Nagar	Female	2 years	Was eating rope, wool, paper and mud for the last 1½ months. Weight had reduced.
8.	Arya Nagar	Female	2½ years	Was eating wool, paper and mud for the last 1 month and was weak.
9.	Piran-wali	Feamle	2½ years	Was eating mud and earth; had tick and lice infestation
10.	Piran-wali	Female	3 years	Was eating mud, licking, manger; had dermatitis and severe tick and lice infestation in winter months.

Sr.No.	Place	Sex	Age	Hisotry
11.	Piran-wali	Female	3 years	Was eating clothes, rope, polythene bags, licking walls and had eaten one bed sheet 15 days ago.
12.	Hisar	Female	5 years	Was eating clothes, bricks and stones for the last 1½ months. Milk yield had reduced from 10 kg to 5 kg per day.
13.	Hisar	Female	5 years	Was eating mud voraciously, had abdominal oedema and was weak and emaciated.
14.	Piran-wala	Female	6 years	Was eating mud, rope and licking walls for last 1 month.
15.	Hisar	Female	6½ years	Was eating clothes, rope and licking kachcha walls for the last 6 months.
16.	Piran-wala	Female	8 years	Was eating mud, rope, licking walls and passing loose faeces for last 3 months.

Table 2. Showing sex, age and history of different cases of pica affected cattle

Sr.No.	Place	Sex	Age	History
1.	Hisar	Female	3 months	Was eating small pieces of bricks and licking walls for the last one month
2.	Piran-wali	Male	4 months	Was eating mud and rags and licking the coats of other animals for last 15 days.
3.	Hisar	Female	5 months	Was eating mud and licking coats of other animals for the last one month.
4.	Piran-wali	Female	8 months	Was eating mud for last three months; it was very weak and had diarrhoea.
5.	Arya	Female	1 year	Was eating mud and licking walls and manger for the last two months
6.	Piran-wali	Male	1 year	Was eating mud for last two months. Owner gave half kg of red chillies but no response.
7.	Hisar	Male	2 years	Was eating mud and clothes for last 1½ months. It was also licking bucket (for watering) and chewing rope (by which tied).
8.	Arya Nagar	Male	2½ years	Was eating mud, puur, paper and bricks for last six months. Animal was very weak.
9.	Piran-wali	Female	4 years	Was eating bricks and cow dung cake for last two months.
10.	Piran-wali	Male	4 years	Animal had been purchased 8-10 months ago and was eating mud since then. It showed signs of abdominal pain every 8-10 days for the last two months.
11.	Piran-wali	Female	4 years	Was eating bricks for last 5 months. Milk yield had reduced from 12 kg to 6 kg per day
12.	Hisar	Female	4½ years	Was eating cow dung cake and mud and licking walls for the last four months, milk yield had reduced from 8 kg to 3 kg per day.

Sr.No.	Place	Sex	Age	History
13.	Arya Nagar	Male	5 years	Was eating mud voraciously and licking coats of other animals for last 8 months. It was very weak and emaciated.
14.	Arya Nagar	Male	6 years	Was eating mud voraciously and licking coats of other animals. It was very weak and emaciated.
15.	Arya Nagar	Male	6 years	Was eating mud, stones, bricks and faeces of other animals for last three months.
16.	Hisar	Female	6 years	Was eating bricks and ash (even burning ash) for last six months. Milk yield had reduced from 10 kg to 5 kg per day. Mineral mixture (local make) was given by the owner but it did not have any effect on cow.
17.	Piran-wali	Female	6 years	Was eating mud for last 1½ months and was very weak. Milk yield had reduced from 10 kg to 7 kg per day.
18.	Hisar	Female	6 years	Was eating bricks and licking ground for last 2 months. Milk yield had reduced from 6 kg to 3 kg per day.
19.	Piran-wali	Female	6 years	Was eating bricks, kachcha walls and slimy sand for last 5 months. Milk yield had reduced by 3 kg compared to last lactation per day.
20.	Arya Nagar	Male	7 years	Was taking large quantities of mud, stones, bricks and faeces of other animals for last 9-10 months. It had become weak and emaciated.

between three to five years and seven were between five to seven years.

Symptoms recorded in these buffaloes and cattle (Table 1, 2) suffering from pica were dull appearance, rough and lusterless hair coat. Initially they licked or nibbled the abnormal material and the quantity of abnormal material eaten increased with the advancement of pica and their condition deteriorated further. They sometimes passed soft and sometimes hard feces in small quantities. At times these animals showed diarrhoea. Milk yield in lactating animals got reduced drastically, even by more than 50%, in few animals leading to heavy economic losses to the farmers.

Haematological studies - Buffaloes

Haemoglobin

Mean Haemoglobin (gm %) was 9.72±0.41, 11.92±0.91 and 13.02±0.85 on day zero, 20 and 40 of the treatment with albendazole (Tables 3, 4, 5, 15 and Fig. 1) and 8.85±0.81, 10.27±0.95 and 11.82±0.62 on day zero, 20 and 40of the treatment with ivermection (Tables 6, 7, 8, 16 and Fig. 2), respectively. These values in both the treatments were significantly different from each other at $P<0.05$.

Packed cell volume (PCV)

Mean PCV (per cent) values were 31.87±1.80, 38.25±3.41, and 41.75±3.41 on day zero, 20 and 40 of the treatment with

Table 3. Haemotological values of pica affected buffaloes on day zero of the treatment with Albendazole

Sr. No.	Hb (g%)	PCV (%)	TEC (10^6/cmm)	TLC (per cmm)	MCV (cμ)	MCHC (%)
1	9.66	31	4.92	7650	63.00	30.96
2	9.8	32	5.02	7850	63.74	30.62
3	10.2	34	5.42	7400	62.73	30.00
4	10.4	35	5.71	8200	61.29	29.71
5	9.8	32	4.97	6800	64.38	30.62
6	9.4	31	4.72	7250	65.67	30.32
7	9.2	30	4.52	6300	66.37	30.66
8	9.4	30	4.57	9400	65.64	31.33
Mean ± SD	9.72 ±0.41	31.87 ±1.80	4.98 ±0.41	7606.25 ±937.86	64.10 ±1.73	30.52 ±0.51

Table 4. Haematological values of pica affected buffaloes on day 20 of the treatment with albendazole

Sr. No.	Hb (g%)	PCV (%)	TEC (10^6/cmm)	TLC (per cmm)	MCV (cμ)	MCHC (%)
1	12	39	5.83	7900	66.89	30.76
2	12.4	40	5.87	7800	68.14	31.00
3	12.8	41	5.98	7500	68.56	31.21
4	13.0	43	6.18	8150	69.57	30.23
5	12.2	39	5.76	7200	67.70	31.28
6	10.4	33	4.98	7750	66.26	31.51
7	10.8	34	5.16	6550	65.89	31.76
8	11.8	37	5.65	9500	65.48	31.89
Mean ± SD	11.92 ±0.91	38.25 ±3.41	5.67 ±0.40	7793.75 ±848.29	67.31 ±1.42	31.20 ±0.54

Table 5. Haematological values of pica affected buffaloes on day 40 of the treatment with albendazole

Sr. No.	Hb (g%)	PCV (%)	TEC (10^6/cmm)	TLC (per cmm)	MCV (cμ)	MCHC (%)
1	12.8	41	6.03	8300	67.79	31.21
2	13.2	43	6.20	7600	69.35	30.23
3	13.6	45	6.53	7850	68.91	30.22
4	14.4	46	6.97	8200	65.99	31.30
5	13.2	43	6.23	7150	69.02	30.69
6	11.4	35	5.02	7300	69.72	32.57
7	12.8	40	5.88	7200	68.02	32.00
8	12.8	41	5.93	9450	69.13	31.21
Mean ± SD	13.02 ±0.85	41.75 ±3.41	6.09 ±0.56	7881.25 ±770.40	68.51 ±1.18	31.17 ±0.81

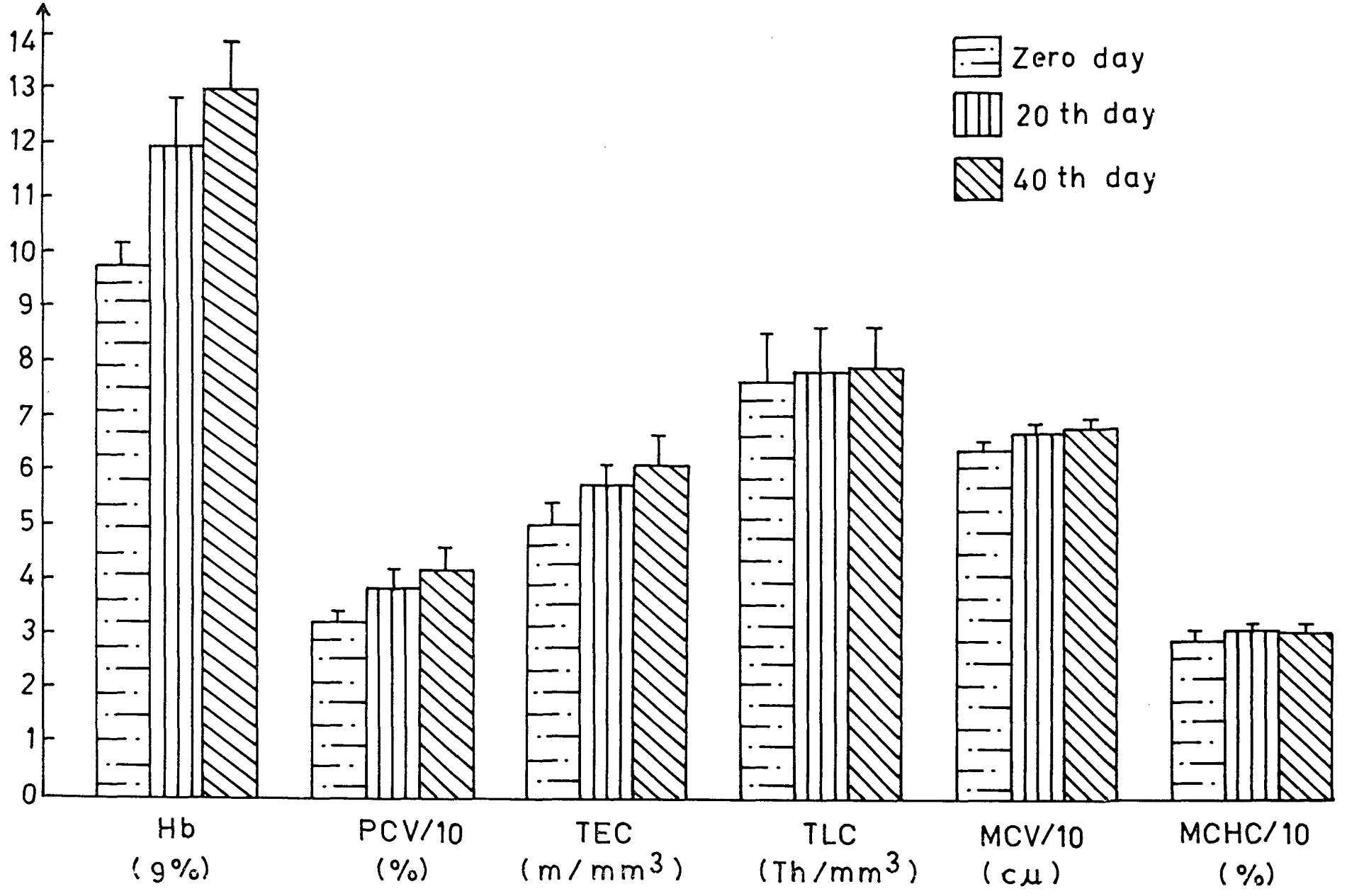


FIG. 1. SHOWING HAEMATOLOGICAL VALUES OF PICA AFFECTED BUFFALOES AND TREATED WITH ALBENDAZOLE.

Table 6. Haematological values of pica affected buffaloes on day zero of the treatment with Ivermectin

Sr. No.	Hb (g%)	PCV (%)	TEC (10^6/cmm)	TLC (per cmm)	MCV (cμ)	MCHC (%)
1	8.8	28	4.27	9250	65.57	37.42
2	9.4	30	4.49	9850	66.81	31.33
3	7.8	26	4.21	9800	61.75	30.00
4	9.2	30	4.78	7650	62.76	30.66
5	8.6	28	4.57	8300	61.26	30.71
6	8.2	25	4.13	6750	60.53	32.80
7	10.4	32	4.98	8900	64.25	32.50
8	8.4	28	4.67	9650	59.95	30.00
Mean ± SD	8.85 ±0.81	28.37 ±2.26	4.51 ±0.29	8768.75 ±1121.52	62.86 ±2.36	31.17 ±1.05

Table 7. Haematological values of pica affected buffaloes on day 20 of the treatment with Ivermectin

Sr. No.	Hb (g%)	PCV (%)	TEC (10^6/cmm)	TLC (per cmm)	MCV (cμ)	MCHC (%)
1	10.2	31	4.82	9750	64.31	32.90
2	11.2	35	5.33	9600	65.66	32.00
3	9.4	30	4.58	9600	65.02	31.33
4	10.8	35	5.38	8100	65.05	30.85
5	11.2	36	5.62	8750	64.05	31.11
6	9.0	29	4.31	6900	67.28	31.03
7	11.2	35	5.43	9650	64.45	32.00
8	9.2	28	4.39	9300	63.78	32.85
Mean ± SD	10.27 ±0.95	32.37 ±3.20	4.98 ±0.51	8956.25 ±1004.43	64.95 ±1.12	31.75 ±0.80

Table 8. Haematological values of pica affected buffaloes on day 40 of the treatment with Ivermectin

Sr. No.	Hb (g%)	PCV (%)	TEC (10^6/cmm)	TLC (per cmm)	MCV (cμ)	MCHC (%)
1	12.0	38	5.67	9200	67.01	31.57
2	12.4	39	5.74	9350	67.94	31.79
3	11.8	36	5.61	9400	64.17	32.77
4	11.8	37	5.78	8300	64.01	31.89
5	12.4	39	5.95	8650	65.54	31.79
6	11.8	37	5.68	7300	65.14	31.89
7	12.0	38	5.92	10050	64.18	31.57
8	10.4	32	4.67	9100	68.52	32.5
Mean ± SD	11.82 ±0.62	37 ±2.26	5.62 ±0.40	8918 ±835.35	65.81 ±1.79	31.97 ±0.43

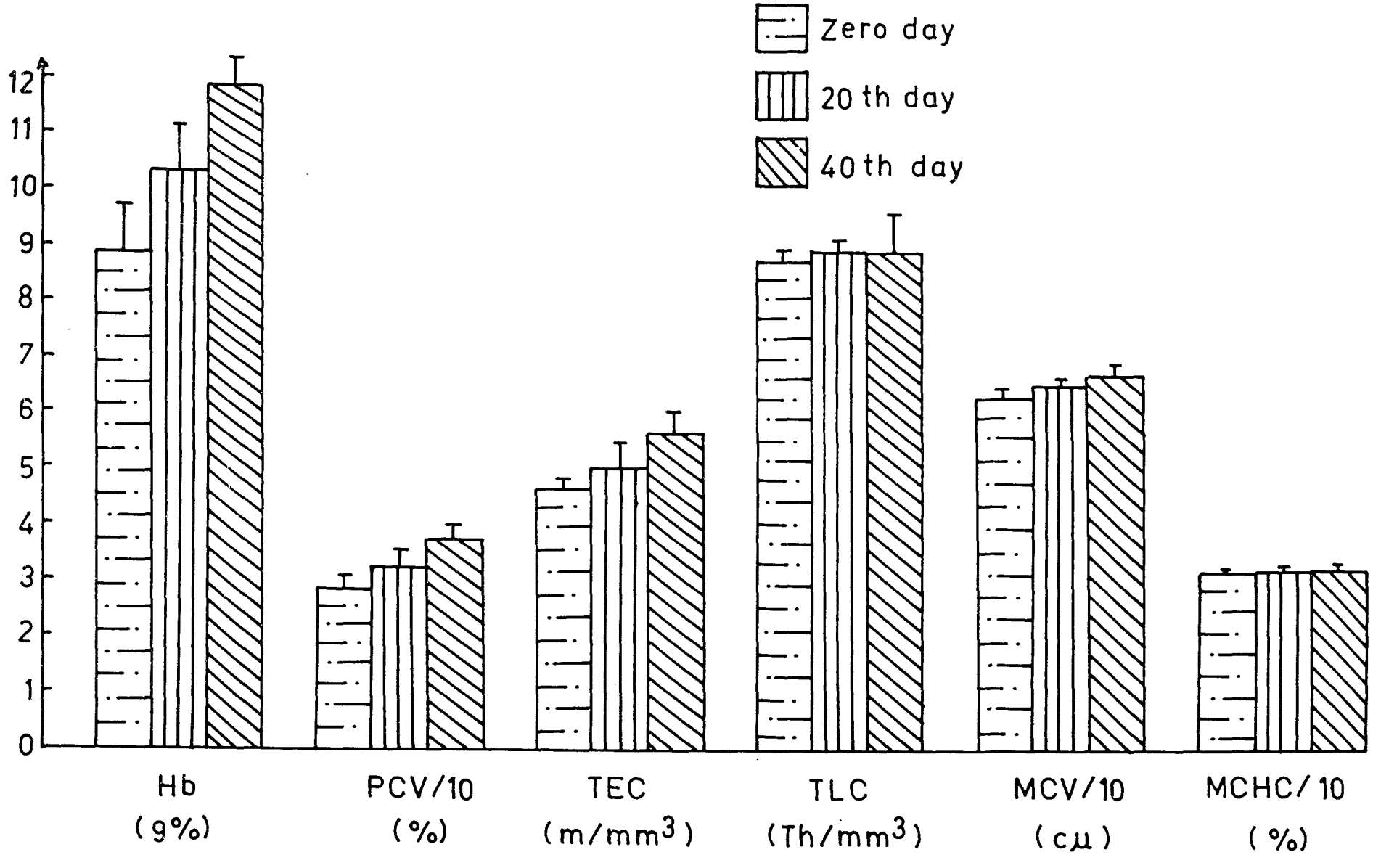


FIG. 2. SHOWING HAEMATOLOGICAL VALUES OF PICA AFFECTED BUFFALOES AND TREATED WITH IVERMECTIN.

albendazole (Tables 3, 4, 5, 15 and Fig 1) and 28.37±2.28, 32.37±3.2 and 37.00±2.26 on day zero, 20 and 40 of the treatment with ivermection (Tables 6, 7, 8, 16 and Fig 2), respectively. These values in both the treatments differed significantly from each other at $P<0.05$.

Total erythrocytic count (TEC)

Mean TEC values (m/mm^3) were 4.98±0.41, 5.67±0.40 and 6.09±0.56 on day zero, 20 and 40 of the treatment with albendazole (Tables 3, 4, 5, 15 and Fig 1), respectively and these values differed significantly from each other at $P<0.05$.

Mean TEC values were 4.51±0.29, 4.98±0.51 and 5.62±0.40 on day zero, 20 and 40 of the treatment with ivermectin (Tables 6, 7, 8, 16 and Fig 2), respectively, and values of day zero and 20 differed significantly from that of day 40 values at $P<0.05$).

Total leucocytic count (TLC)

Mean TLC values (Th/mm^3) were 7.60±0.93, 7.79±0.84 and 7.88±0.77 on day zero, 20 and 40 of treatment with albendazole (Tables 3, 4, 5, 15 and Fig 1) and 8.76±1.12, 8.95±1.04 and 8.91±0.83 on day zero, 20 and 40 of the treatment with ivermectin (Tables 6, 7, 8, 16 and Fig 2), respectively. None of these values were significantly differed from each other.

Mean corpuscular value (MCV)

Mean MCV values in (cμ) were 64.10±1.73, 67.31±1.42 and 68.51±1.18 on day zero, 20 and 40 of the treatment with albendazole (Table 3, 4, 5, 15 and Fig. 1), respectively and day zero values differed significantly at $P<0.05$ from that of the values of day 20 and 40.

Similarly, mean MCV values were 62.86±2.46, 64.95±1.12 and 65.81±1.75 on day zero, 20 and 40 of the treatment with ivermectin (Tables 6, 7, 8, 16 and Fig. 2), respectively and values of day zero differed significantly from that of the values of day 20 and 40 at $P<0.05$.

Mean corpuscular haemoglobin concentration (MCHC)

Mean MCHC values in percentage were 30.52±0.51, 31.20±0.54 and 31.17±0.81 on day zero, 20 and 40, respectively of the treatment with albendazole (Tables 3, 4, 5, 15 and Fig. 1) and these values did not differ significantly from each other at $P<0.05$.

Similarly, mean MCHC values were 31.17±1.05, 31.75±0.808 and 31.97±0.43 on day zero, 20 and 40 of the treatment with ivermectin (Tables 6, 7, 8, 16 and Fig. 2), respectively and these values did not differ significantly from each other at $P<0.05$.

Serum biochemical studies - Buffaloes

Calcium

Mean serum calcium levels were non-significantly different with values of 8.18±0.85 on day zero, 8.18±0.73 on day 20 and 8.41±0.56 on day 40 of treatment with albendazole, respectively (Table 9, 10, 11, 15 and Fig. 3).

Similarly, the buffaloes treated with ivermectin had these values as 8.29±0.86, 8.42±0.91, 8.63±0.92 on day zero, 20 and 40, respectively (Tables 12, 13, 14, 16 and Fig. 4) which were non-significant at $P<0.05$.

Phosphorus

Mean serum phosphorus levels were 3.55±0.57, 4.16±0.58 and 4.58±0.52 on day zero, 20 and 40 of treatment with albendazole, respectively 9Tables 9, 10, 11, 15 and Fig. 3) and these were significantly different at $P<0.05$.

Similarly, the mean values of phosphorus were 3.5±0.7, 4.17±0.54 and 4.67±0.51 on day zero, 20 and 40 of treatment with ivermectin, respectively (Table 12, 13, 14, 16 and Fig 4) which were significantly different from each other at $P<0.05$.

Magnesium

Mean serum magnesium levels were 2.85±0.55, 2.78±0.54 and 2.78 on day zero, 20 and 40 of treatment with albendazole, respectively (Tables 9, 10, 11, 15 and Fig 3) and 2.79±0.65,

Table 9. Biochemical values of pica affected buffaloes on day zero of the treatment with albendazole

Sr. No.	Ca (mg/dl)	P (mg/dl)	Mg (mg/dl)	Na (mEq/l)	K (mEq/l)	Fe (µg/dl)
1	7.80	3.35	2.97	168	6.33	102
2	8.1	4.47	3.32	164	6.00	107
3	9.2	3.06	1.87	124	4.33	112
4	9.5	3.45	2.38	112	4.00	118
5	7.3	3.14	3.50	128	4.66	106
6	7.6	4.23	3.32	142	5.00	98
7	8.7	3.88	2.52	148	5.33	96
8	7.3	2.86	2.74	122	4.33	102
Mean ± SD	8.18 ±0.85	3.55 ±0.57	2.82 ±0.55	138.5 ±20.41	4.99 ±0.83	105.12 ±7.27

Table 10. Biochemical values of pica affected buffaloes on day 20 of the tratment with albendazole

Sr. No.	Ca (mg/dl)	P (mg/dl)	Mg (mg/dl)	Na (mEq/l)	K (mEq/l)	Fe (µg/dl)
1	8.2	3.88	2.97	152	5.33	130
2	8.4	4.78	3.41	172	6.33	132
3	9.0	3.66	2.00	136	4.66	138
4	9.2	3.88	2.38	124	4.33	142
5	7.6	3.76	3.23	132	4.33	126
6	7.9	4.99	3.41	136	4.66	112
7	8.3	4.78	2.59	142	5.00	118
8	6.9	3.56	2.31	136	4.66	126
Mean ± SD	8.18 ±0.73	4.16 ±0.58	2.78 ±0.54	141.25 ±14.77	4.91 ±0.66	128 ±9.85

Table 11. Biochemical values of pica affected buffaloes on day 40 of the treatment with albendazole

Sr. No.	Ca (mg/dl)	P (mg/dl)	Mg (mg/dl)	Na (mEq/l)	K (mEq/l)	Fe (µg/dl)
1	8.2	4.47	2.82	156	5.33	132
2	8.3	5.13	3.23	168	6.00	136
3	9.1	4.11	2.38	138	4.66	144
4	9.3	4.34	2.45	130	4.33	146
5	8.1	4.34	3.14	136	4.66	132
6	8.3	5.27	3.23	142	5.00	118
7	8.5	5.13	2.67	146	5.33	132
8	7.5	3.88	2.38	132	4.33	134
Mean ± SD	8.41 ±0.56	4.58 ±0.52	2.78 ±0.37	143.5 ±12.90	4.95 ±0.57	134.25 ±8.58

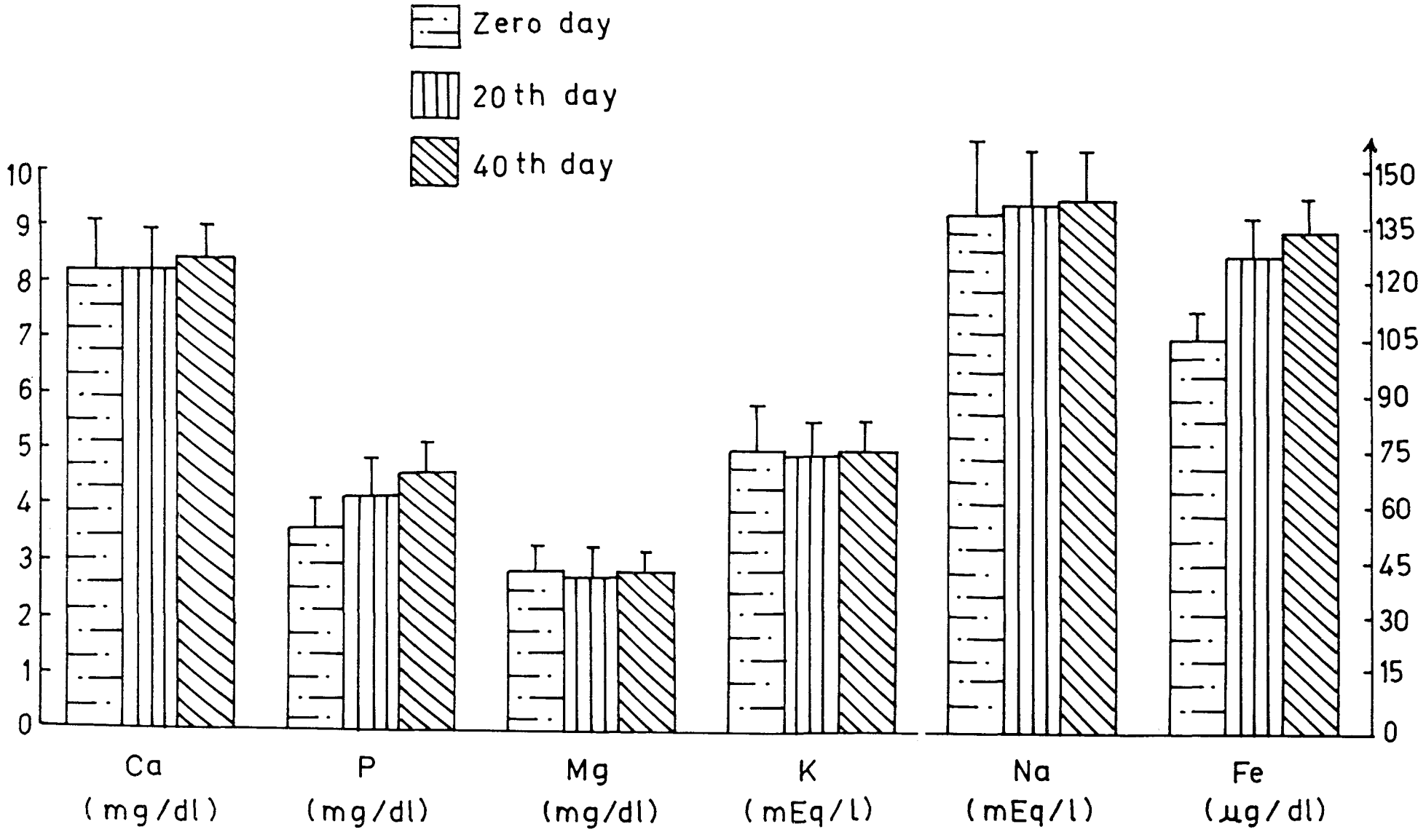


FIG. 3. SHOWING SERUM BIOCHEMICAL VALUES OF PICA AFFECTED BUFFALOES AND TREATED WITH ALBENDAZOLE.

Table 12. Biochemical values of pica affected buffaloes on day zero of the treatment with ivermectin

Sr. No.	Ca (mg/dl)	P (mg/dl)	Mg (mg/dl)	Na (mEq/l)	K (mEq/l)	Fe (µg/dl)
1	9.0	3.25	2.85	108	2.66	92
2	7.8	3.14	3.91	136	4.66	88
3	6.9	2.95	1.93	152	5.00	72
4	8.5	3.76	3.32	94	3.33	86
5	7.9	4.78	2.31	106	3.66	82
6	9.8	3.66	2.18	138	4.66	84
7	8.4	4.00	3.14	122	4.00	112
8	8.0	2.50	2.74	114	4.00	88
Mean ± SD	8.29 ±0.86	3.50 ±0.70	2.79 ±0.65	121.25 ±19.44	4.12 ±0.58	88 ±11.36

Table 13. Biochemical values of pica affected buffaloes on day 20 of the treatment with ivermectin

Sr. No.	Ca (mg/dl)	P (mg/dl)	Mg (mg/dl)	Na (mEq/l)	K (mEq/l)	Fe (µg/dl)
1	9.5	4.00	2.67	118	4.00	104
2	8.2	3.88	3.50	130	4.33	122
3	7.3	3.66	2.08	146	5.00	98
4	8.2	4.60	3.14	116	4.00	112
5	7.8	5.13	2.45	120	4.00	126
6	10.1	4.23	1.93	136	4.66	90
7	8.0	4.47	2.85	134	4.66	120
8	8.3	3.45	2.67	128	4.33	96
Mean ± SD	8.42 ±0.91	4.17 ±0.54	2.66 ±0.51	128.5 ±10.23	4.37 ±0.37	108.5 ±13.42

Table 14. Biochemical values of pica affected buffaloes on day 40 of the treatment with ivermectin

Sr. No.	Ca (mg/dl)	P (mg/dl)	Mg (mg/dl)	Na (mEq/l)	K (mEq/l)	Fe (µg/dl)
1	9.7	4.19	2.74	124	4.33	118
2	7.9	4.60	3.50	138	4.66	136
3	7.4	4.23	2.18	146	5.00	112
4	8.6	5.13	3.06	126	4.00	126
5	8.2	5.41	2.52	132	4.33	134
6	10.2	4.73	2.08	136	4.66	122
7	8.3	5.13	2.97	136	4.66	132
8	8.8	4.00	2.67	132	4.33	108
Mean ± SD	8.63 ±0.92	4.67 0.51	2.71 0.46	133.75 6.96	4.49 0.30	123.5 10.35

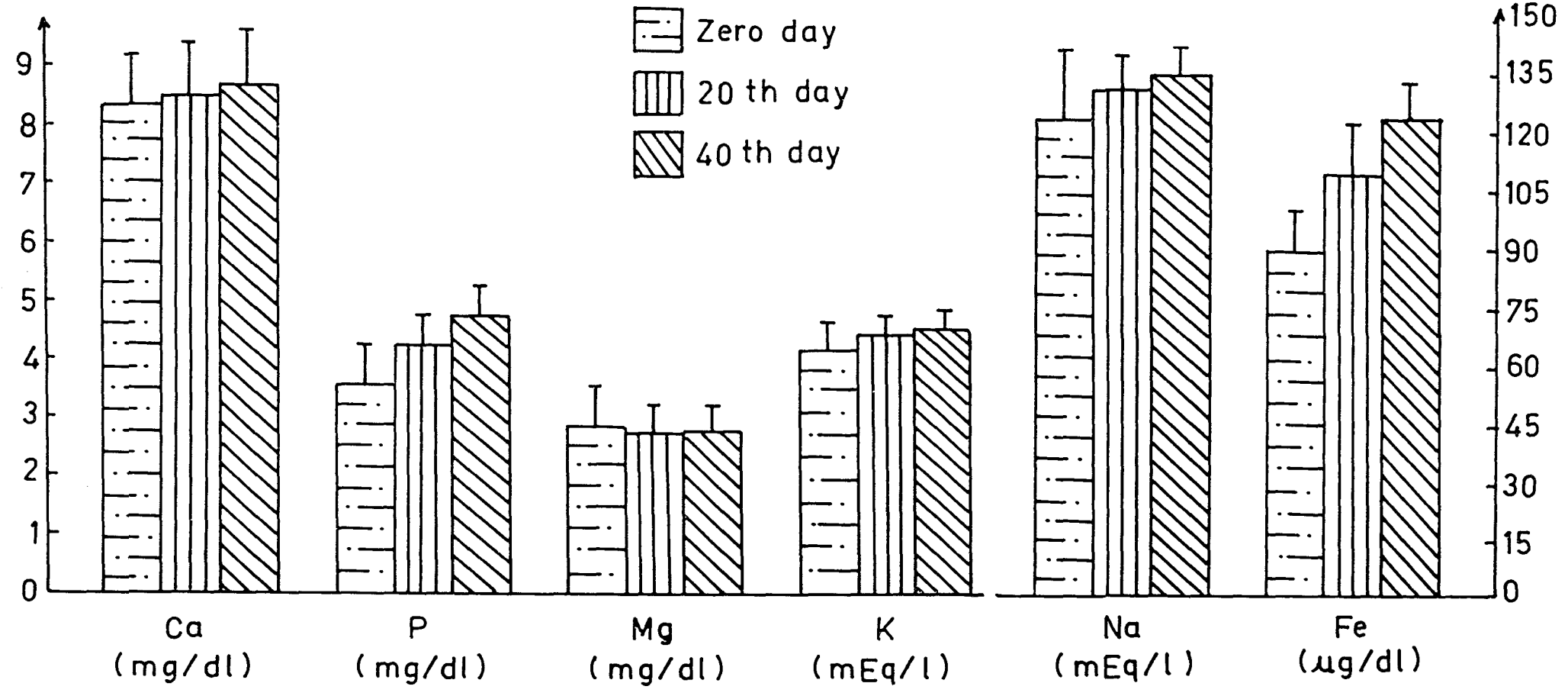


FIG. 4. SHOWING BIOCHEMICAL VALUES OF PICA AFFECTED BUFFALOES AND TREATED WITH IVERMECTIN.

Table 15. Mean biochemical and hematological values of 8 buffaloes suffering from pica and treated with albendazole*

Parameters	Observations on day		
	0	20	40
Hb (g %)	9.72[a] ±0.41	11.92[b] ±0.91	13.02[c] ±0.85
PCV (%)	31.87[a] ±1.80	38.25[b] ±3.41	41.75[c] ±3.41
TEC (m/mm^3)	4.98[a] ±0.41	5.67[b] ±0.40	6.09[c] ±0.56
TLC (Th/mm^3)	7.60 ±0.93	7.79 ±0.84	7.88 ±0.77
MCV (cμ)	64.10[a] ±1.73	67.31[b] ±1.42	68.51[b] ±1.18
MCHC (%)	30.52 ±0.51	31.20 ±0.54	31.17 ±0.81
Ca (mg/dl)	8.18 ±0.85	8.18 ±0.73	8.41 ±0.56
P (mg/dl)	3.55[a] ±0.57	4.16[b] ±0.58	4.58[b] ±0.52
Mg (mg/dl)	2.82 ±0.55	2.78 ±0.54	2.78 ±0.37
Na (mEq/l)	138.5 ±20.41	141.25 ±14.77	143.5 ±12.9
K (mEq/l)	4.99 ±0.83	4.91 ±10.66	4.95 ±0.57
Fe (μg/dl)	105.12[a] ±7.27	128.00[b] ±9.85	134.25[b] ±8.58

* albendasole @ 5 mg/kg body weight, orally.

a. Significantly different from b and c at $p<0.05$.

b. Significantly different from a and c at $p<0.05$.

c. Significantly different from a and b at $p<0.05$.

Table 16. Mean biochemical and haematological values of 8 buffaloes suffereing from pica and treated with ivermectin*

Parameters	Observations on day		
	0	20	40
Hb (g %)	8.85[a] ±0.81	10.27[b] ±0.95	11.82[c] ±0.62
PCV (%)	28.37[a] ±2.38	32.37[b] ±3.20	37.00[c] ±2.26
TEC (m/mm^3)	4.51[a] ±0.29	4.98[a] ±0.51	5.62[b] ±0.40
TLC (Th/mm^3)	8.76 ±1.12	8.95 ±1.04	8.93 ±0.83
MCV (cμ)	62.86[a] ±2.46	64.95[b] ±1.12	65.81[b] ±1.79
MCHC (%)	31.17 ±1.05	31.75 ±0.81	31.97 ±0.43
Ca (mg/dl)	8.29 ±0.86	8.42 ±0.91	8.63 ±0.92
P (mg/dl)	3.5[a] ±0.7	4.17[b] ±0.54	4.67[c] ±0.51
Mg (mg/dl)	2.79 ±0.65	2.66 ±0.51	2.71 ±0.46
Na (mEq/l)	121.25 ±19.44	128.50 ±10.23	133.75 ±6.96
K (mEq/l)	4.12 ±0.58	4.37 ±0.67	4.49 ±0.30
Fe (μg/dl)	88.00[a] ±11.36	108.50[b] ±13.42	123.50[c] ±10.35

*Ivermectin @ 200 ug/kg body weight subcutaneously.

a. Significantly different from b and c at $p<0.05$.

b. Significantly different from a and c at $p<0.05$.

c. Significantly different from a and b at $p<0.05$.

2.66±0.51 and 2.71±0.46 on day zero, 20 and 40 of treatment with ivermectin, respectively (Tables 12, 13, 14, 16 and Fig. 4) and all these values were non-significantly different form each other at $P<0.05$.

Sodium

Mean serum sodium levels were 138.5±20.41, 141.25±14.77 and 143.5±12.9, respectively on day zero, 20 and 40 of the treatment with albendazole, respectively (Tables 9, 10, 11, 15 and Fig. 3) and 121.25±19.44, 128.5±10.23 and 133.75±6.96 on day zero, 20 and 40 of treatment with ivermectin, respectively (Tables 12, 13, 14, 16 and Fig. 4). Despite an increase by 12.5 mEq/l in buffaloes treated with ivermectin, these values were non-significant at 5% levels.

Potassium

Mean serum potassium levels (mEq/l) were 4.99±0.83, 4.91+0.66 and 4.95±0.57 on day zero, 20 and 40 of treatment with albendazole, respectively (Tables 9, 10, 11, 15 and Fig. 3) and 4.12±0.58, 4.37±0.37, 4.47±0.3 on day zero, 20 and 40 of treatment with invermectin (Tables 12, 13, 14, 16 and Fig. 4) respectively. These values did not differ significantly from each other at $P<0.05$.

Iron

Mean serum iron levels (µg/dl) were 105.12±7.27, 128±9.85 and 134.25±8.58 on day zero, 20 and 40 of treatment with albendazole, respectively (Tables 9, 10, 11, 15 and Fig 3). The values on day 20 and 40 were not significantly different from each other but both these were significantly from the day zero values at $P<0.05$.

Similarly, with ivermectin these values wer 88.00±11.36, 108.50±13.92 and 123.5±10.35 on day zero, 20 and 40, respectively which were significantly different from each other at $P<0.05$.

Chemotherapeutic studies

The details of the chemotherapeutic studies in albendazole and ivermectin on buffaloes have been summarized in tables 17 and 18.

Of the eight buffaloes treated with albendazole, the EPG reduced to less than 100 on day 40 of the treatment and in these cases it was 100 per cent effective against Toxocaca vitulorum, Haemonchus, Strongyloides and Bunostomum species, but was not 100 per cent effective against Trichuris sp. and of the eight buffaloes treated with ivermectin the EPG reduced by 90 per cent and the drug was 100 per cent effective against Toxocaca vitulorum, Strongyloides, Haemonchus, Trichostrongylus species but not 100 per cent effective against Trichuris species.

Table 17. Showing eggs per gram of faeces and parasites recovered in buffaloes treated with albendazole

Sr. No.	Observations on day 0	10	20	40	Parasite found
1	400	-	-	-	Toxocara vitulorum*
2	600	-	-	-	Toxocara vitulorum*
3	700	-	-	-	Hemonchus Strongyloides
4	200	-	-	-	Hemonchus
5	500	-	-	-	Hemonchus
6	200	-	100	-	Trichuris*
7	-	-	-	-	Hemonchus
8	300	-	-	-	Bunostomum

*The species of these parasites could be recognised without culturing.

Table 18. Showing eggs per gram of faeces and parasites recovered in buffaloes treated with ivermectin

Sr. No.	Observations on day 0	10	20	40	Parasite found
1	100	-	-	-	Toxocara vitulorum*
2	600	-	-	-	Toxocara vitulorum*
3	100	-	-	-	Strongyloides
4	-	-	-	-	Hemonchus
5	-	-	-	-	Hemonchus
6	300	-	-	-	Trichostrongylus Hemonchus
7	700	100	100	200	Trichuris* Hemonchus
8	200	-	-	-	Hemonchus

* The species of these parasites could be recognised without culturing.

Haematological studies - Cattle

Haemoglobin (Hb)

Hb levels (gm %) were 9.17±1.19, 11.12±1.05 and 12.54±0.81 on day zero, 20 and 40 of the treatment with albendazole (Tables 19, 20, 21, 31 and Fig. 5), respectively which differed significantly from each other at $P<0.05$.

Similarly, Hb levels were 9.84±1.04, 11.52±0.84 and 12.82±1.05 on day zero, 20 and 40, respectively of the treatment with ivermectin (Tables 22, 23, 24, 32 and Fig. 6) which differed significantly at 5 per cent levels of significance from each other.

Packed cell volume (PCV)

PCV (per cent) levels were 29.9±4.25, 35.3±3.26 and 39.2+2.89, respectively on day zero, 20 and 40 of the treatment with albendazole, respectively (Tables 19, 20, 21, 31 and Fig. 5) which differed significantly from each other at 5 per cent level.

Similarly, PCV levels were 32.2±3.73, 36.3±2.86 and 39.2+3.53 on day zero, 20 and 40 of the treatment with ivermectin, respectively (Tables 22, 23, 24, 32 and Fig. 6) which differed significantly from each other at $P<0.05$.

Total erythrocytic count (TEC)

TEC (m/mm^3) were 4.71±0.57, 5.33±0.52 and 5.79±0.49 on

Table 19. Haematological values of pica affected cattle on day zero of the treatment with albendazole

Sr. No.	Hb (g%)	PCV (%)	TEC (10^6/cmm)	TLC (per cmm)	MCV (cμ)	MCHC (%)
1	10.6	34	5.42	8900	62.73	31.17
2	8.2	26	4.34	7000	59.90	31.53
3	7.5	25	3.92	8150	63.77	30.00
4	9.2	30	4.78	6300	62.76	30.66
5	9.0	29	4.62	10200	62.77	31.03
6	9.6	31	4.80	9300	64.58	30.96
7	9.4	0	4.80	10300	62.50	31.33
8	9.8	32	5.04	6500	63.49	30.62
9	11.0	38	5.57	9850	68.22	28.94
10	7.4	24	3.82	8800	62.82	30.83
Mean ± SD	9.17 ±1.19	29.9 ±4.25	4.71 ±0.57	8530 ±1492.42	63.35 ±2.09	30.70 ±0.75

Table 20. Haematological values of pica affected cattle on day 20 of the treatment with albendazole

Sr. No.	Hb (g%)	PCV (%)	TEC (10^6/cmm)	TLC (per cmm)	MCV (cμ)	MCHC (%)
1	11.8	38	5.57	9300	68.22	31.05
2	10.0	32	4.82	7600	66.39	31.25
3	10.2	34	4.98	8200	68.27	30.00
4	10.8	35	5.28	6700	66.28	30.85
5	11.6	36	5.42	10200	66.42	32.22
6	11.8	37	5.67	9100	65.25	31.89
7	11.0	35	5.47	10100	63.98	31.42
8	11.2	36	5.46	6750	65.93	31.11
9	13.2	41	6.27	10150	65.39	32.48
10	9.6	29	4.35	8900	66.66	33.10
Mean ± SD	11.12 ±1.05	35.3 ±3.26	5.32 ±0.52	8700 ±1338.94	66.27 ±1.29	31.53 ±0.89

Table 21. Haematological values of pica affected cattle on day 40 of the treatment with albendazole

Sr. No.	Hb (g%)	PCV (%)	TEC (10^6/cmm)	TLC (per cmm)	MCV (cμ)	MCHC (%)
1	12.6	39	5.72	9200	68.18	32.30
2	12.0	38	5.47	7850	69.46	31.57
3	11.8	36	5.33	8300	67.54	32.77
4	12.2	38	5.56	6800	68.34	32.10
5	12.8	40	5.81	9950	68.84	32.00
6	13.0	41	6.17	9000	66.45	31.70
7	13.6	42	6.27	10150	66.98	32.38
8	12.8	40	6.01	7200	66.55	32.00
9	13.6	44	6.66	9850	66.06	30.90
10	11.0	34	4.97	8800	68.41	32.35
Mean ± SD	12.54 ±0.81	39.2 ±2.89	5.79 ±0.49	8710 ±1158.49	67.68 ±1.13	32.00 ±0.52

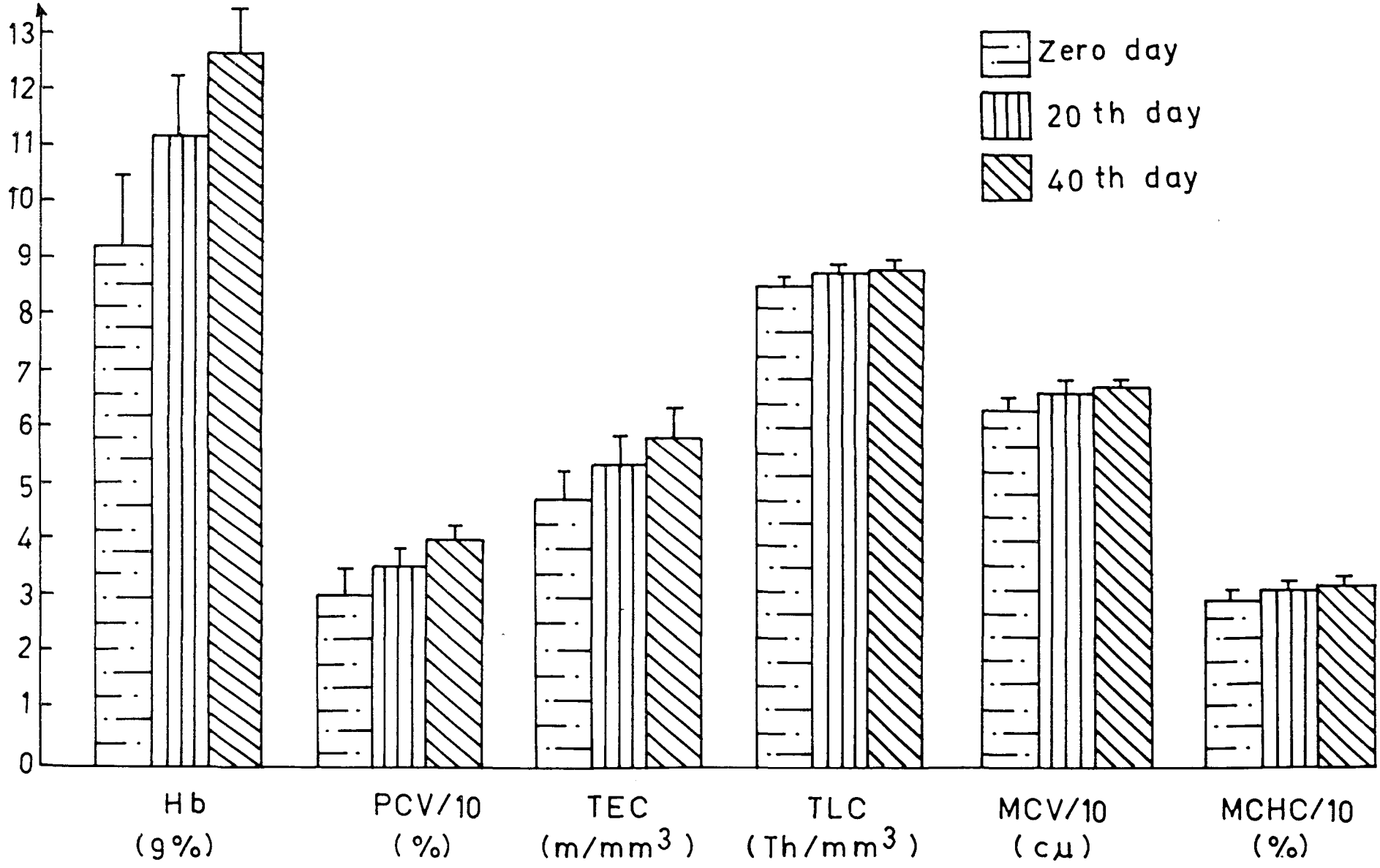


FIG. 5. SHOWING HAEMATOLOGICAL VALUES OF PICA AFFECTED CATTLE AND TREATED WITH ALBENDAZOLE.

Table 22. Haematological values of pica affected cattle on day zero of the treatment with ivermectin

Sr. No.	Hb (g%)	PCV (%)	TEC (10^6/cmm)	TLC (per cmm)	MCV (cu)	MCHC (%)
1	10.2	33	5.15	9200	64.07	30.90
2	9.2	31	4.82	7850	64.31	29.67
3	11.0	36	5.21	8350	69.09	30.55
4	12.0	39	6.24	6250	62.50	30.76
5	10.2	35	5.07	9850	69.03	29.14
6	9.2	30	4.85	8600	61.85	30.55
7	8.8	28	4.37	7350	64.07	31.42
8	9.4	30	4.81	9200	62.37	31.33
9	8.6	27	4.32	9700	62.50	31.85
10	9.8	33	5.21	8450	633.33	29.69
Mean ± SD	9.84 ±1.04	32.2 ±3.73	5.00 ±0.53	8480 ±1109.6	64.31 ±2.63	30.59 ±0.86

Table 23. Haematological values of pica affected cattle on day 20 of the treatment with ivermectin

Sr. No.	Hb (g%)	PCV (%)	TEC (10^6/cmm)	TLC (per cmm)	MCV (cμ)	MCHC (%)
1	12.4	39	5.88	9750	66.32	31.79
2	11.0	35	5.45	8200	64.22	31.42
3	12.4	39	5.78	8300	67.47	31.79
4	12.6	40	6.23	6800	64.20	31.50
5	11.8	37	5.69	9600	65.02	31.89
6	11.6	35	5.38	8500	65.05	33.14
7	11.0	34	5.23	7600	65.00	32.35
8	10.2	32	5.00	9050	64.00	31.87
9	10.4	33	51.6	9450	63.95	31.51
10	11.8	39	5.91	8600	65.98	30.25
Mean ± SD	11.52 ±0.84	36.3 ±2.86	5.57 ±0.38	8585 ±927.67	65.12 ±1.15	31.75 ±0.73

Table 24. Haematological values of pica affected cattle on day 40 of the treatment with ivermectin

Sr. No.	Hb (g%)	PCV (%)	TEC (10^6/cmm)	TLC (per cmm)	MCV (cμ)	MCHC (%)
1	13.2	41	6.07	16100	67.54	32.19
2	12.8	39	5.84	8000	66.78	32.82
3	13.0	41	6.21	8200	66.02	31.70
4	14.8	45	6.76	7350	66.56	32.88
5	13.6	43	6.53	9400	65.84	31.62
6	12.8	39	5.95	8850	65.54	32.82
7	12.6	38	5.81	8200	65.40	33.15
8	11.2	34	4.87	8800	69.81	32.94
9	11.2	34	4.93	9600	68.96	32.94
10	13.0	41	6.05	8950	67.76	31.70
Mean ± SD	12.82 ±1.05	39.5 ±3.53	5.90 ±0.60	8725 ±826.05	67.02 ±1.48	32.47 ±0.60

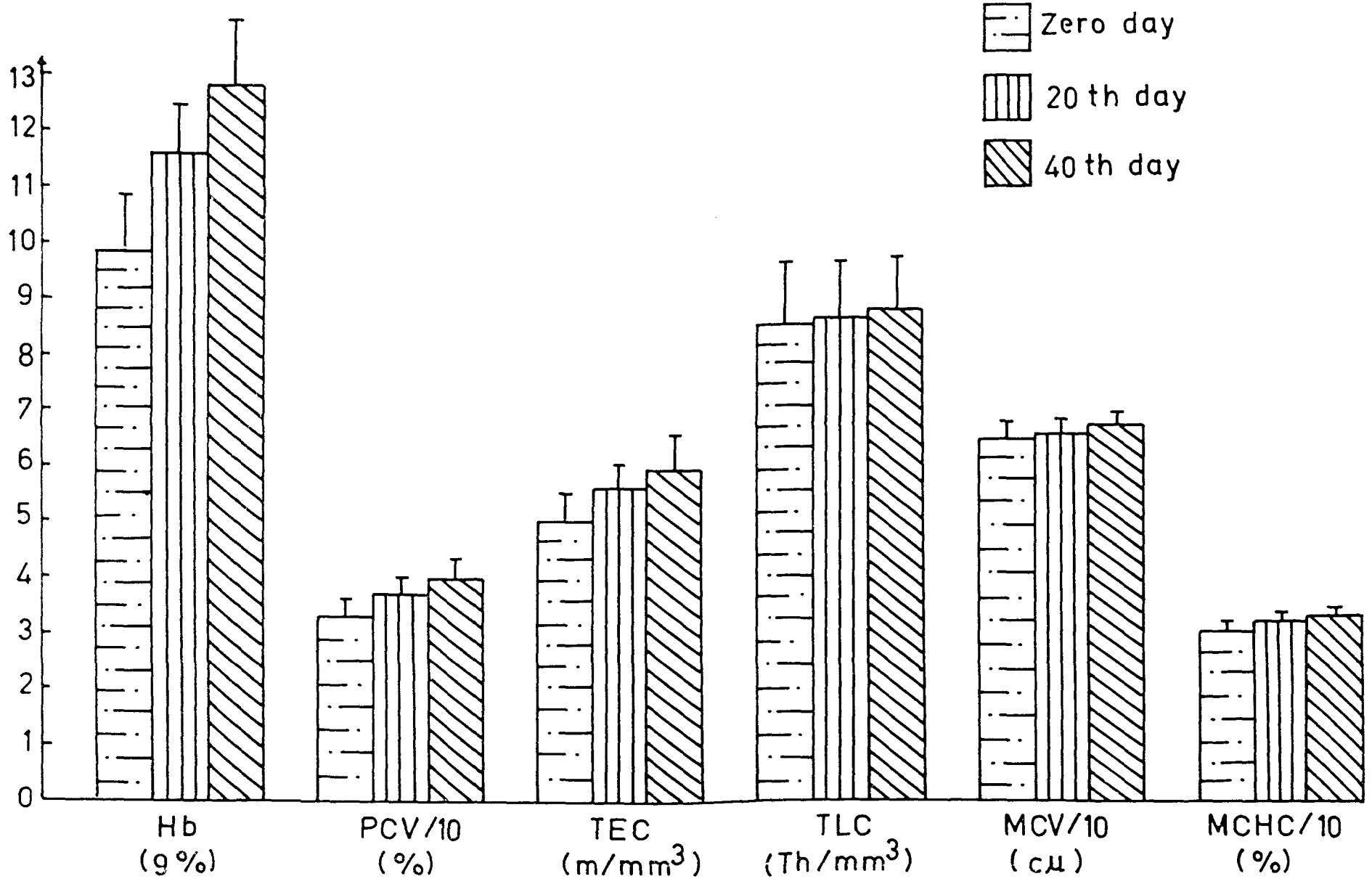


FIG. 6. SHOWING HAEMATOLOGICAL VALUES OF PICA AFFECTED CATTLE AND TREATED WITH IVERMECTIN.

day zero, 20 and 40 of the treatment with albendazole, respectively (Tables 19, 20, 21, 31 and Fig. 5) which differed significantly form each other at $P<0.05$.

TEC values were 5.00 ± 0.53, 5.57 ± 0.38 and 5.9 ± 0.60 on day zero, 20 and 40 of the treatment with ivermectin, respectively (Tables 22, 23, 24, 32 and Fig. 6) and day zero values differed significantly from the values of day 20 and 40 at $P<0.05$.

Total leucocytic count (TLC)

TLC (Th/mm^3) values were 8.53 ± 1.49, 8.7 ± 1.33 and 8.71 ± 1.15 on day zero, 20 and 40 of the treatment with albendazole (Tables 19, 20, 21, 31 and Fig. 5) which did not differ significantly at 5 per cent level.

Similarly, TLC values were 8.48 ± 1.10, 8.58 ± 0.92 and 8.72+0.82 on day zero, 20 and 40 of the treatment with ivermectin, respectively (Tables 22, 23, 24, 32 and Fig 6) which did not differ significantly from each other at 5 per cent level.

Mean corpuscular volueme (MCV)

MCV values ($c\mu$) were 63.35 ± 2.09, 66.27 ± 1.29 and 67.68 ± 1.13 on day zero, 20 and 40 of the treatment with albendazole, respectively (Tables 19, 20, 21, 31 and Fig. 5). Day 20 and 40 values did not differ significantly from each other at 5 per cent level, but both these values differed significantly from day zero values at 5 per cent levels indicating microcytic anaemia.

Similarly, MCV values were 64.31±2.63, 65.12±1.15 and 67.02±1.48 on day zero, 20 and 40 of the treatment, respectively with ivermectin (Tables 22, 23, 24, 32 and Fig. 6). Values of day zero and 20 differed significantly from day 40 values at 5 per cent levels indicating microcytic anaemia.

Mean corpuscular haemoglobin concentration (MCHC)

MCHC values (per cent) were 30.7±0.75, 31.53±0.89 and 32.00±0.52 on day zero, 20 and 40 of the treatment with albendazole, respectively (Tables 19, 20, 21, 31 and Fig. 5) and values of day zero differed significantly from that of day 20 and 40 at 5 per cent level indiating hypochromic anaemia.

Similarly, MCHC values were 30.59±0.86, 31.75±0.73 and 32.47±0.60 on day zero, 20 and 40 of the treatment with ivermectin, respectively (Tables 22, 23, 24, 32 and Fig. 6) and values of day zero differed significantly from that of day 20 and 40 at 5 per cent level indicating hypochromic anaemia.

Biochemical studies - Cattle

Calcium

Mean serum calcium levels in mg/dl were 8.5±0.77, 8.67±0.73 and 8.8±0.83 on day zero, 20 and 40 of treatment, respectively with albendazole (Tables 25, 26, 27, 31 and Fig. 7) which did not differ significantly from each other at 5 per cent level.

Table 25. Biochemical values of pica affected cattle on day zero of the treatment with albendazole

Sr. No.	Ca (mg/dl)	P (mg/dl)	Mg (mg/dl)	Na (mEq/l)	K (mEq/l)	Fe (µg/dl)
1	8.1	3.45	2.38	124	4.66	108
2	9.0	2.95	3.06	138	5.00	86
3	7.9	4.23	2.85	94	3.66	72
4	9.7	3.45	2.74	108	4.00	96
5	9.7	2.77	3.14	122	4.33	90
6	8.7	3.88	2.52	144	4.66	102
7	8.3	3.14	2.31	128	4.33	98
8	7.3	3.66	3.14	136	5.00	104
9	8.3	4.47	3.70	112	4.00	112
10	8.0	2.86	1.93	114	4.33	68
Mean ± SD	8.5 ±0.77	3.48 ±0.57	2.77 ±0.51	122 ±15.34	4.39 ±0.43	93.6 ±14.69

Table 26. Biochemical values of pica affected cattle on day 20 of the treatment with albendazole

Sr. No.	Ca (mg/dl)	P (mg/dl)	Mg (mg/dl)	Na (mEq/l)	K (mEq/l)	Fe (µg/dl)
1	8.4	3.76	2.45	132	5.00	126
2	9.2	4.11	3.14	140	5.33	102
3	8.1	4.73	2.67	116	4.00	108
4	9.6	3.88	2.52	124	4.33	110
5	9.8	3.66	2.97	132	4.66	132
6	9.2	4.60	2.38	152	5.33	134
7	8.3	4.34	2.52	136	4.66	122
8	7.6	4.47	3.23	138	5.00	120
9	8.5	5.13	3.41	120	4.00	146
10	8.0	3.66	2.18	122	4.00	98
Mean ± SD	8.67 ±0.73	4.23 ±0.50	2.74 ±0.41	131.2 ±10.92	4.63 ±0.53	119.8 ±15.30

Table 27. Biochemical values of pica affected cattle on day 40 of the treatment with albendazole

Sr. No.	Ca (mg/dl)	P (mg/dl)	Mg (mg/dl)	Na (mEq/l)	K (mEq/l)	Fe (µg/dl)
1	8.3	4.00	2.45	136	4.66	138
2	9.5	4.34	3.23	144	5.00	130
3	8.3	4.78	2.74	120	4.33	126
4	9.4	4.34	2.67	124	4.33	132
5	10.3	3.88	2.74	128	4.66	138
6	9.4	4.78	2.52	146	5.00	142
7	8.5	4.34	2.45	132	4.33	148
8	7.4	4.60	3.32	142	5.00	140
9	8.6	5.27	3.41	128	4.66	150
10	8.3	4.00	2.31	126	4.33	116
Mean ± SD	8.8 ±0.83	4.43 ±0.43	2.78 ±0.39	132.6 ±8.99	4.63 ±0.29	136 ±10.28

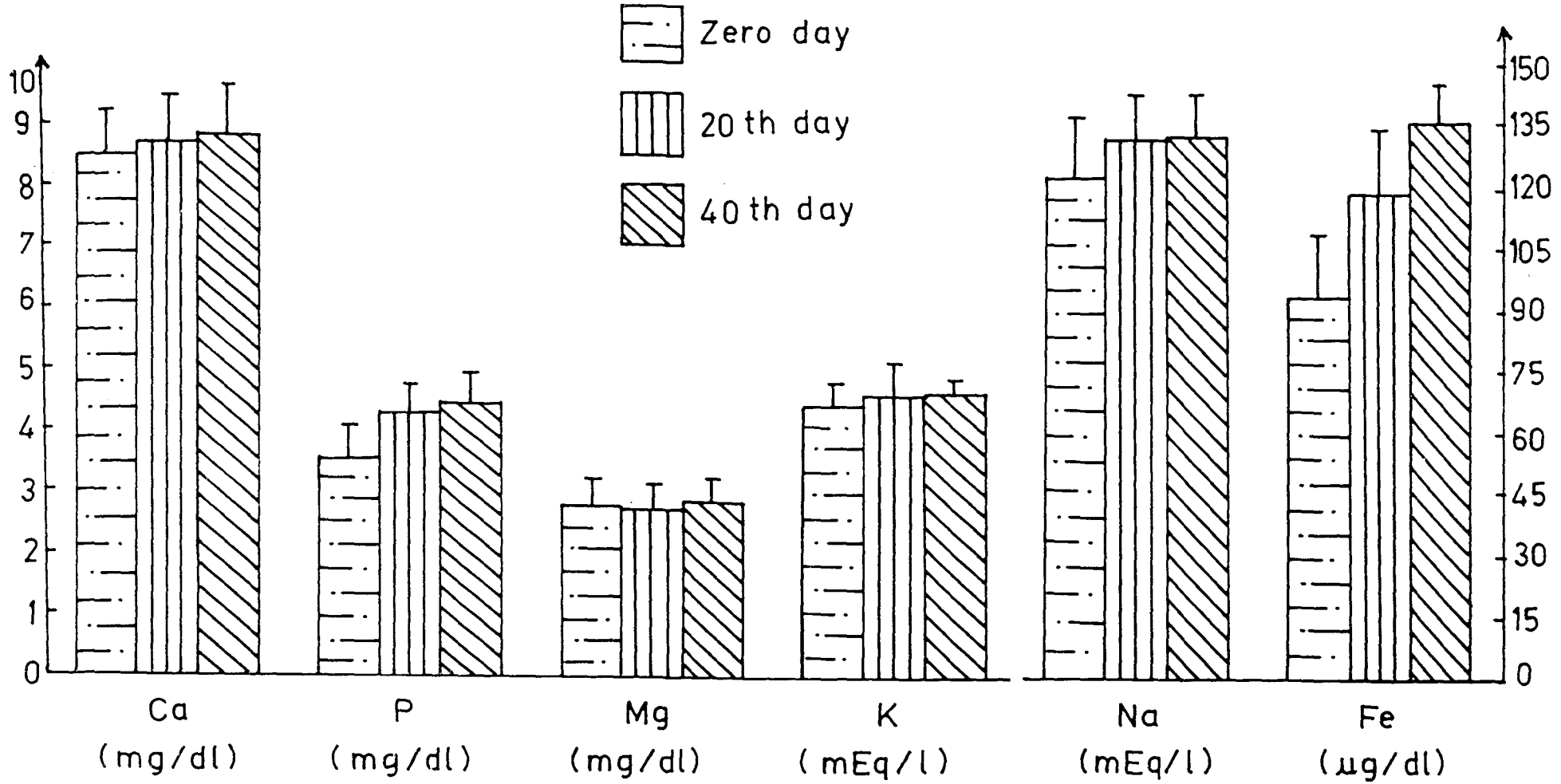


FIG. 7. SHOWING SERUM BIOCHEMICAL VALUES OF PICA AFFECTED CATTLE AND TREATED WITH ALBENDAZOLE.

Table 28. Biochemical values of pica affected cattle on day zero of the treatment with ivermectin

Sr. No.	Ca (mg/dl)	P (mg/dl)	Mg (mg/dl)	Na (mEq/l)	K (mEq/l)	Fe (µg/dl)
1	9.1	3.88	2.82	152	5.66	106
2	7.2	5.13	3.32	124	4.33	94
3	8.4	3.76	3.70	154	5.33	114
4	7.8	4.78	2.18	110	4.00	122
5	7.6	3.66	2.38	106	3.66	104
6	8.8	2.77	3.50	96	3.66	96
7	7.9	2.77	3.70	142	4.66	84
8	8.7	3.45	1.87	120	4.33	94
9	8.2	3.76	2.12	136	5.00	84
10	7.7	3.45	2.38	174	6.33	102
Mean ± SD	8.14 ±0.60	3.74 ±0.75	2.79 ±0.70	131.4 ±24.55	4.69 ±0.88	100 ±12.18

Table 29. Biochemical values of pica affected cattle on day 20 of the treatment with ivermectin

Sr. No.	Ca (mg/dl)	P (mg/dl)	Mg (mg/dl)	Na (mEq/l)	K (mEq/l)	Fe (µg/dl)
1	8.8	4.34	2.67	144	4.66	138
2	7.4	5.27	3.41	136	4.33	124
3	9.0	4.23	3.60	162	5.66	132
4	8.3	4.99	2.25	124	4.00	134
5	7.9	4.00	2.31	114	3.66	128
6	8.6	3.45	3.32	112	3.66	130
7	7.5	3.56	3.41	146	5.00	118
8	8.2	4.47	2.00	136	4.33	106
9	7.8	4.47	2.25	138	4.66	108
10	7.4	4.11	2.59	170	6.00	128
Mean ± SD	8.09 ±0.58	4.28 ±0.56	2.78 ±0.59	138.2 ±18.72	4.59 ±0.78	124.6 ±10.75

Table 30. Biochemical values of pica affected cattle on day 40 of the treatment with ivermectin

Sr. No.	Ca (mg/dl)	P (mg/dl)	Mg (mg/dl)	Na (mEq/l)	K (mEq/l)	Fe (µg/dl)
1	8.9	4.78	2.74	148	5.00	144
2	7.6	5.57	3.50	140	4.66	138
3	8.8	4.73	3.50	158	5.33	142
4	8.5	5.13	2.38	132	4.66	158
5	8.0	4.34	2.38	122	4.33	146
6	8.7	3.66	3.41	128	4.33	140
7	8.2	3.88	3.70	140	4.66	136
8	9.0	4.99	2.12	134	4.66	122
9	8.4	5.13	2.25	138	5.00	120
10	7.5	4.34	2.67	166	5.66	144
Mean	8.36	4.65	2.86	140.6	4.82	139
± SD	±0.52	±0.59	±0.60	±13.46	±0.42	±11.20

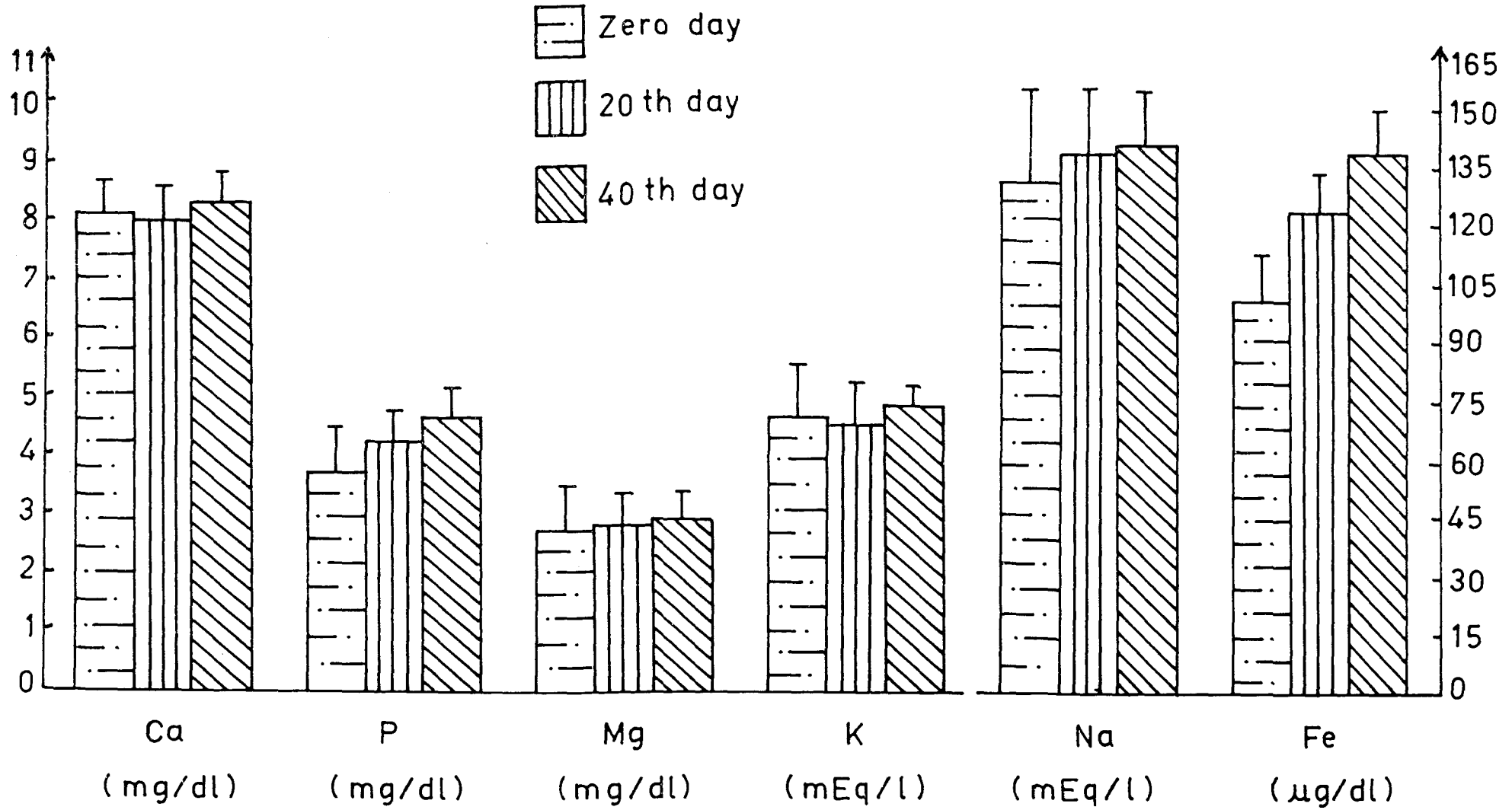


FIG. 8. SHOWING SERUM BIOCHEMICAL VALUES OF PICA AFFECTED CATTLE AND TREATED WITH IVERMECTIN.

Table 31. Mean biochemical and haematological values of 10 cattle suffering from pica and treated with albendazole*

Parameters	Observations on day		
	0	20	40
Hb (g %)	9.17[a] ±1.19	11.12[b] ±1.05	12.54[c] ±0.81
PCV (%)	29.90[a] ±4.25	35.50[b] ±3.26	39.20[c] ±2.89
TEC (m/mm^3)	4.71[a] ±0.57	5.33[b] ±0.52	5.79[c] ±0.49
TLC (Th/mm^3)	8.53 ±1.49	8.70 ±1.33	8.71 ±1.15
MCV (cμ)	63.35[a] ±2.09	66.27[b] ±1.29	67.68[b] ±1.13
MCHC (%)	30.70[a] ±0.75	31.53[b] ±0.89	32.00[b] ±0.52
Ca (mg/dl)	8.50 ±0.77	8.67 ±0.73	8.80 ±0.83
P (mg/dl)	3.48[a] ±0.57	4.23[b] ±0.50	4.43[b] ±0.43
Mg (mg/dl)	2.77 ±0.51	2.74 ±0.41	2.78 ±0.39
Na (mEq/l)	122.00 ±15.34	131.20 ±10.92	132.6 ±8.99
K (mEq/l)	4.39 ±0.43	4.63 ±0.53	4.63 ±0.29
Fe (μg/dl)	93.6[a] ±14.69	119.8[b] ±15.30	136.00[c] ±10.28

*Albendazole @ 5 mg/kg body weight orally.

a. Significantly different from b and c at $p<0.05$.

b. Significantly different from a and c at $p<0.05$.

c. Significantly different from a and b at $p<0.05$.

Table 32. Mean biochemical and haematological values of 10 cattle suffering from pica and treated with ivermectin*

Parameters	Observations on day		
	0	20	40
Hb (g %)	9.84[a] ±1.04	11.52[b] ±0.84	12.82[c] ±1.05
PCV (%)	32.20[a] ±3.73	36.30[b] ±2.86	39.20[c] ±3.53
TEC (m/mm^3)	5.00[a] ±0.53	5.57[b] ±0.38	5.90[b] ±0.60
TLC (Th/mm^3)	8.48 ±1.10	8.58 ±0.92	8.72 ±0.82
MCV (cμ)	64.31[a] ±2.63	65.12[a] ±1.15	67.02[b] ±1.48
MCHC (%)	30.59[a] ±0.86	31.75[b] ±0.73	32.47[b] ±0.60
Ca (mg/dl)	8.14 ±0.60	8.09 ±0.58	8.36 ±0.52
P (mg/dl)	3.74[a] ±0.75	4.28[b] ±0.56	4.65[b] ±0.59
Mg (mg/dl)	2.79 ±0.70	2.78 ±0.59	2.86 ±0.60
Na (mEq/l)	131.40 ±24.55	138.20 ±18.72	140.60 ±13.46
K (mEq/l)	4.69 ±0.88	4.59 ±0.78	4.82 ±0.42
Fe (μg/dl)	100.00[a] ±12.18	124.6[b] ±10.75	139.00[c] ±11.20

*Ivermectin @ 200 ug/kg body weight subcutaneously

a. Significantly different from b and c at $p<0.05$.

b. Significantly different from a and c at $p<0.05$.

c. Significantly different from a and b at $p<0.05$.

Similarly, mean serum calcium levels were 8.14±0.6, 8.09±0.58 and 8.36±0.52 on day zero, 20 and 40 of the treatment with invermectin, respectively (Tables 28, 29, 30, 32 and Fig 8) which did not differ significantly from each other at 5 per cent level.

Phosphorus

Mean serum phosphorus levels (mg/dl) were 3.48±0.57, 4.23±0.50 and 4.43±0.43 on day zero, 20 and 40 of the treatment with albendazole, respectively (Tables 25, 26, 27, 31 and Fig. 7) and values of day zero were significantly low as compared to that of day 20 and 40 at $P<0.05$.

Similarly, mean serum phosphorus levels were 3.74±0.75, 4.28±0.56 and 4.65±0.59 on day zero, 20 and 40 of the treatment with ivermectin, respectively (Tables 28, 29, 3, 32 and Fig. 8) and values of day zero were significantly low as compared to values of day 20 and 40 at $P<0.05$.

Magnesium

Mean serum magnesium levels (mg/dl) were 2.77±0.51, 2.74+0.41 and 2.78±0.39 on day zero, 20 and 40 of treatment with albendazole, respectively (Tables 25, 26, 27, 31 and Fig. 7) which did not differ significantly at $P<0.05$.

Similarly, serum magnesium values were 2.79±0.70, 2.78±0.59 and 2.86±0.60 on day zero, 20 and 40, respectively

of treatment with ivermectin (Tables 28, 29, 30, 32 and Fig.8) which did not differ significantly at P<0.05.

Sodium

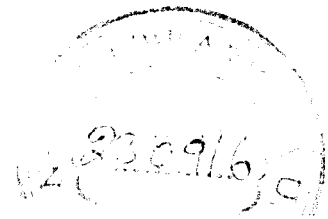
Mean serum sodium levels (mEq/l) were 122.00±15.34, 131.2±10.92 and 132.6±8.99 on day zero, 20 and 40 of the treatment, respectively with albendazole (Tables 25, 26, 27, 31 and Fig 7) which despite an increase did not differ significantly at P<0.05.

Similarly, mean serum sodium levels were 131.4±24.55, 138.2±18.72 and 140.6±13.46 on day zero, 20 and 40, respectively of the treatment with ivermectin (Tables 28, 29, 30, 32 and Fig. 8) which despite increase did not differ significantly at P<0.05.

Potassium

Mean serum potassium levels in (mEq/l) were 4.39±0.43, 4.63±0.53 and 4.63±0.29 on day zero, 20 and 40 of treatment with albendazole, respectively (Tables 25, 26, 27, 31 and Fig. 7) which did not differ significantly from each other at P<0.05.

Similarly, the mean levels of serum potassium were 4.69±0.88, 4.59±0.78 and 8.42±0.42 on day zero, 20 and 40 of treatment with ivermectin, respectively (Tables 28, 29, 30, 32 and Fig. 8) which did not differ significantly from each other at P<0.05.



Iron

Mean serum iron levels (µg/dl) were 93.6±14.69, 119.8±15.30 and 136.0±10.28 on day zero, 20 and 40, respectively of treatment with albendazole (Tables 25, 26, 27, 31 and Fig. 7) which differed significantly from each other at $P<0.05$.

Similarly, the mean serum iron levels were 100.0±12.18, 124.6±10.75 and 139.0±11.2 on day sero, 20 and 40 of treatment with ivermectin, respectively (Tables 28, 29, 30, 32 and Fig.8) which differed significantly form each other at $P<0.05$.

Chemotherapeutic studies

The details of chemotherapeutic studies on albendazole and ivermectin in cattle have been summarized in tables 33 and 34.

Of the 10 cattle treated with albendazole the eggs per gram of feces got reduced by 96 per cent on day 40 of the treatment and it was highly effective against Toxocara vitulorum, Haemonchus trichostrongylus, Nematodirus and Oesophagostomum species but was not effective against Trichuris species and of the 10 cattle treated with ivermectin the EPG of feces got reduced by 97.5 per cent on day 40 of the treatment and invermectin was highly effective against Toxocara vitulorum, Haemonchus, Strongyloids, Oesphagostomum and Trichostrongylus species but not effective against Trichuris species.

Table 33. Showiing egg per gram of faeces and parasites found in cattle treated with albendazole

Sr. No.	Observations on day 0	10	20	40	Parasites found
1	200	-	-	-	Toxocara vitulorum*
2	500	-	-	-	Toxocara vitulorum*
3	100	-	-	-	Nematodirus*
4	600	-	-	-	Haemonchus Trichostrongylus
5	400	-	-	-	Oesophagostomum Haemonchus
6	200	-	-	-	Haemonchus
7	300	200	200	100	Trichostrongylus Trichuris*
8	200	-	-	-	Haemonchus
9	-	-	-	-	Haemonchus
10	-	-	-	-	Trichostrongylus

* The species of these parasites could be recognised without culturing.

Table 34. Showing egg per gram of faeces and parasites found in cattle treated with ivermectin

Sr. No.	Observations on day 0	10	20	40	Parasites found
1	100	-	-	-	Toxocara vitulorum*
2	300	100	200	100	Trichuris*
3	800	-	-	-	Toxocara vitulorum*
4	800	-	-	-	Trichostrongylus Haemonchus
5	600	-	-	-	Strongyloides Haemonchus
6	200	-	-	-	Strongyloides
7	500	-	-	-	Trichostrongylus Haemonchus
8	500	-	-	-	Oesophagostomum Haemonchus
9	200	-	-	-	Oesophagostomum
10	700	-	-	-	Haemonchus Trichostrongylus

* The species of these parasites could be recognised without culturing.

D I S C U S S I O N

DISCUSSION

In this study buffaloes and cattle of both sexes and of all age groups belonging to Hisar (Haryana) and its nearby villages were found suffering from pica. These buffaloes were seen eating mud, bricks, pebbles, rope, rag of clothes, wool, polythene bags and paper and the cattle were seen eating mud, bricks, stones, kachcha walls, ash, faeces, cowdung cake, rags of clothes and paper. No detailed study has been reported on this disease of pica in buffaloes and cattle but Bansal (1993) in his annual report of the scheme entitled 'Investigations on the Diseases of Camels' has reported buffaloes (24 males and 85 females) and cattle (18 males and 49 females) of all age groups to be suffering from pica. Bansal *et al.* (1971) and Singh *et al.* (1986) reported similar findings in cases of pica affected camels.

Haemoglobin values were significantly low in pica affected buffaloes and cattle on day zero as compared to the values on day 20 and 40 of the treatment. These findings are in confirmity to the available results of Bansal *et al.* (1971) and Singh *et al.* (1986) on camels suffering from pica. Total erythrocytic counts were significantly low in pica affected buffaloes and cattle on day zero as compared to the values on day 20 and 40 of the treatment. Similar findings have been reported by Bansal *et al.* (1971) and Singh *et al.* (1986) in clinical cases of pica in camels. These workers attributed

the decrease in TEC to iron deficiency and blood loss due to the blood sucking gastrointestinal parasites, viz. Trichostrongylus, Haemonchus, Trichuris, Oesphagostomum, Strongyloides and Nematodirus species.

Packed cell volume was significantly low in pica affected buffaloes and cattle on day zero as compared to the values on day 20 and 40 of the treatments. Bansal et al. (1971) and Singh et al. (1986) reported the same findings in the clinical cases of camels.

Mean corpuscular volume increased significantly on day 20 and 40 as compared to the values on day zero of the treatment in pica affected buffaloes and there was no significant increase in mean corpuscular haemoglobin concentration. These findings of MCV and MCHC indicated microcytic normochromic anaemia in these pica affected buffaloes and MCV and MCHC values increased significantly on day 20 and 40 as compared to the values on day zero of the treatment in pica affected cattle and this indicated microcytic hypochromic anaemia in these cattle. Bansal et al. (1971) reported microcytic normochromic anaemia and Singh et al. (1986) reported microcytic hypochromic anaemia in clinical cases of camels suffering from pica. Schalm et al. (1975) have mentioned that the microcytic hypochromic anaemias are specific to iron deficiency or failure to utilize iron, chronic loss of blood or iron or copper deficiency must be

considered. They further described that iron deficiency anaemias are rare among domestic animals with the exception of piglet anaemia, anaemia in animals grazing on iron deficient pastures and the individual animals heavily infected with blood sucking parasites. In this study buffaleos were found suffering from gastrointestinal nematodiasis namely Toxocara vitulorum, Haemonchus, Trichostrongylus, strongyloides, Bunostomum and Trichuris species with an EPG of 100 to 700. The cattle were found suffering from Toxocara vitulorum, Haemonchus, Trichostrongylus, Oesophagostomum, Nematodirus, Strongyloides and Trichuris species of parasites with an EPG of 100 to 800. The area was arid to semi arid and green fodders were scanty for the most part of the year. Due to non-availability of the green fodders in this area the buffaloes and cattle were maintained on dry fodder. These factors might explain the possibility of iron deficiency in the pica affected buffaloes and cattle and microcytic hypochromic anaemia. This was further strengthened by the significantly low levels of iron in the sera samples of the pica affected buffaloes and cattle on day zero as compared to the values on day 20 and 40 of the treatment.

Inorganic phosphorus levels were significantly low in the serum of pica affected buffaloes and cattle on day zero as compared to the values on day 20 and 40 of the treatment. This indicated phosphorus deficiency in these animals and

could be attributed to the low levels of phosphorus as reported by Chaudhary and Bhandari (1989) in the soils of the area to which these buffaloes and cattle belonged and grazed of the fodders grown on this area. They found that the phosphorus levels were low to medium in Haryana and 52.2 per cent samples of the soils of the Hisar district were very low in phosphorus content.

Joffe (1949) reported that the concentration of phosphorus in soil is not as important as the availability of phosphorus. He described that in semidesert soils, potassium and phosphorus were fixed on the surface layer. With the irrigation some of the potassium might be released and phosphorus might remain unavailable because of excess of calcium in the soil. This might explain the possibility of phosphorus deficiency in the buffaloes and cattle where even phosphorus content of soil was normal. The presence of Haemonchus species in the abomasum also appear to interfere with the digestibility and absorption of phosphorus (Blood et al., 1989) and in this study 10 buffaloes and 10 cattle were found infected with Haemonchus species.

Similar to these observations post parturient haemoglobinuria in buffaloes (Nagpal, 1968 and Gautam et al., 1972) and rheumatism like syndrome in buffaloes and cattle (Verma, 1981) have also been reported due to phosphorus deficiency.

Pica due to phosphorus deficiency has also been reported in cattle by Runnels et al. (1965), Maynard and Loosli (1969), Blood et al. (1989) and in camels by Bansal et al. (1971), Singh et al. (1986) and Beniwal (1993).

Pica due to the deficiency of sodium in cattle, sheep and horses has been described by Whitlock et al. (1975), Hutyra et al. (1949) and Mayer et al. (1984), respectively, by the deficiency of calcium in cattle by Blood et al. (1989) and by the deficiency of magnesium in children by Gardar et al. (1977). However, in the present study no significant differences were observed in sodium, potassium, calcium and magnesium contents in the serum of the pica affected and treated buffaloes and cattle which indicated that these elements possibly did not play any role in producing pica in these animals of this area.

Serum iron levels were also significantly low in buffaloes and cattle on day zero as compared to the values on day 20 and 40 of the treatment in the present study which could be due to harbouring various blood cucking parasites (Schalm, 1965) by these animals.

Albendazole was 100 per cent efficacious in buffaloes and 96 per cent in cattle. Albendazole was not effective against Trichuris sp. in this area. Delator et al. (1989) compared the efficacy of Netobimin (Pro-albendazole) and albendazole and found these to be excellent against nematodes

in camel, sheep and cattle. Bauer and Hafner (1990) studied the efficacy of netobimin (Pro-albendazole) on sheep and found it 100 per cent effective against Haemonchus, ostertagia, Trichostrogylus, Cooperia, Nematodirus, Strongyloides, Oesophagostomum, Chabertia and Monezia species and 80 per cent effective against Trichuria species. These reports are similar to the findings in this study where albendazole was found 100 per cent effective against Haemonchus, Trichostrongylus, Strongyloides species and Toxocara vitulorum in buffaloes and 100 per cent effective against Haemonchus, Trichostrongylus, Nematodirus, Strongyloides, Oesophagostomum species and Toxocara vitulorum but not against Trichuris species in cattle.

Ivermectin @ 200 µg/kg body weight subcutaneously was 97.1 per cent effective against the nematodes of buffaloes (Toxocara vitulorum, Haemonchus, Trichostrongylus, Strongyloides, Bunostomum and Trichuris species) and 98.2 per cent effective against the nematodes of cattle (Toxocara vitulorum, Haemonchus, Trichostrongylus, Strongyloides, Nematodirus and Trichuris species) and highly effective against ectoparasites in two buffaloes who had severe tick and lice infestations; which is in accordance to the studies of Leaning (1984) in the field cases who found invermectin @ 200 µg/kg body weight to be 95.0 per cent effective against the adult and immature stomach worms and lung worms including

inhibited fourth stage larvae of Ostertagia species and against ectoparasites, sucking lice, psoroptic and sarcoptic mange, mites and warbles, it revealed nearly 100 per cent efficacy.

Similarly, Gill et al. (1989) reported ivermectin to be highly effective against the nematodes except Trichuris species against which it was not 100 per cent effective and found ivermectin 100 per cent effective against ectoparasites.

Shastry (1989) found ivermectin to be 90.38 to 97.26 per cent effective against Toxocara vitulorum infection in 10 buffalo calves.

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSIONS

Buffaloes suffering from pica in this study had significantly low levels of haemoglobin (Hb), packed cell volume (PCV), total erythrocytic count (TLC) and mean corpuscular volume (MCV) on day zero as compared to the values on day 20 and 40 of the treatment with albendazole and ivermectin, indicating microcytic normochromic anaemia in these buffaloes.

The biochemical studies were carried out on serum calcium, phosphorus, magnesium, sodium, potassium and iron. Phosphorus and iron levels showed significantly low levels on day zero as compared to the values on day 20 and 40 of the treatment.

Mean EPG was 290 and 200 on day zero and got reduced to nil and 20 on day 40 of the treatment with albendazole and invermectin, respectively indicating 100 per cent efficacy of albendazole and 96 per cent efficacy of ivermection. These buffaloes suffered from single or multiple infections of T.vitulorum, Strongyloides, Haemonchus, Bunostomum, Trichostrongylus and Trichuris species.

Cattle suffering from pica in this study had significantly low levels of Hb, PCV, TLC, MCV and MCHC on day zero as

compared to the values on day 20 and 40 of the treatmetn with albendazole and ivermectin, indicating microcytic hypochromic anaemia in these cattle.

Biochemical studies were carried out on calcium, phosphorus, magnesium, sodium, potassium and iron. Phosphorus and iron levels were significantly low in pica cases on day zero as compared to the values on day 20 and 40 of the treatment.

Mean EPG was 250 and 470 on day zero and got reduced to 10 and 10 on day 40 of the treatment with albendazole and ivermectin, respectively indicating 96 per cent efficacy of albendazole and 95 per cent efficacy of ivermectin. These cattle suffered from single or multiple infections of T.vitulorum, Haemonchus, Trichostrongylus, Strongyloides, Nematatodirus and Trichuris species.

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