Efficacy of clinically used anthelmintics against toxocariasis of buffalo calves in Bangladesh

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Abstract Toxocariasis is a paramount parasitic disease having > 50% prevalence among newborn buffalo calves in Bangladesh. The objective of this study was to compare the efficacy of clinically used anthelmintics and their subsequent effect on the haematological parameters and body weight in buffalo calves in commercial buffalo farms in coastal region. Thirty-two buffalo calves below 3 months of age with clinical Toxocara infection had been selected and treated with albendazole (ABZ), levamisole (LVM) and ivermectin (IVM). The EPG counts, hematological parameters and initial body weight of buffalo calves were recorded on the day of anthelmintic treatment (day 0). Fecal samples were collected on day 14 and 28 including hematological parameters and body weight were recorded on day 28 post-treatment. The efficacy (%) of anthelmintics were estimated by fecal egg count reduction test (FECRT). The parameters like Hb, PCV, ESR, TEC, TLC were analyzed from the blood samples. The FECRT revealed 96.83% efficacy for IVM followed by 94.23% and 85.84% for LVM and ABZ, respectively. Anthelmintic treated calves showed significant (p < 0.01) increase in Hb, PCV, TEC and body weight, and decrease in ESR and TLC as a result of worm expulsion from buffalo calves after 28 days of post-treatment. Among the tested anthelmintics, IVM was found to be more effective against toxocariasis in buffalo calves. This is a novel information on anthelmintics efficacy in buffalo calves in Bangladesh. Details study is recommended on the efficacy of anthelmintics in different buffalo management systems by in vitro egg hatch assay (EHA) test.

Keywords Buffalo calves · Toxocariasis · Anthelmintic · FECRT · Bangladesh

Introduction

Buffalo is an integral component of livestock and considered one of the important livestock species for poverty alleviation and socio-economic development in Bangladesh. These animals have significant contribution to the agricultural economy of the country and are mainly utilized in the production of meat, milk, and additionally for draft power especially in the rural and marginal areas where there is lack of facilities of modern mechanization (Islam et al. 2017; Mason and Cockrill 1974). Like other domestic animals, buffalo are easy to rear due to their ability to survive on the marginal land with low-quality forages, resistant to diseases and adapt to different topographies, soils and climates. Recently, the government has taken buffalo development project to fulfill the growing demand for livestock products, food security and nutritional requirement of ever-growing population of the country. However, the improvement of buffalo production in the country is constrained by several factors including the gastrointestinal (GI) parasitic diseases. Among the GI parasites, the ascarid nematode Toxocara vitulorum (T. vitulorum) is common and responsible for high morbidity and mortality in younger calves, especially buffalo calves in the tropical and subtropical countries (Abdel-Rahman and El-Ashmawy 2013; Dorny et al. 2015; Roberts 1990a; Srivastava 1963).

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Toxocarasis is characterized by severe diarrhea, poor performance, uncompensated stunted growth rate, anemia, weight loss and anorexia, particularly in buffalo calves between 1 and 3 months of age (Dacasto and Cocuzza 1995; Einstein et al. 1994; Roberts 1990b; Srivastava 1963). Toxocara infection is associated with a marked biochemical alteration of the affected calves which leads to their poor growth performances (Das et al. 2018). The diverse geo-climatic conditions, animal husbandry practices and pasture management are influencing the incidence and severity of various diseases of buffalo in Bangladesh (BMD 2021; Fox et al. 2012). The control of the Toxocara infection is difficult since the calves become infected directly from their dams via vertical transmission (transplacental and trans-mammary) and causes serious health impact with a high percentage of calf mortality (Roberts 1990b; Soulsby 1968).

Apparently, there is no alternative for controlling of helminth parasites in ruminants other than the anthelmintic treatment. There are three major classes of anthelmintics that are commonly used to control the nematode infection of livestock, viz., benzimidazoles (albendazole), nicotinic agonists (levamisole) and macrocyclic lactones (ivermectin). Albendazole acts by its inhibitory effect on the tubulin polymerization (Barrowman et al. 1984) however, levamisole has an immuno-regulatory mode of action through forming a mimicry of a thymic hormone thymopoietin (Goldstein 1978), and ivermectin binds to glutamate-activated chloride channels existing in nerve or muscle cells of nematode with a specific and high affinity, causing hyperpolarization of nerve or muscle cells by increasing permeability of chloride ion through the cell membrane as a result, the parasites are paralyzed to death (Ikeda 2003) Anthelmintic activities, potency and therapies of albendazole, levamisole and ivermectin have been studied previously in the world (Alsaad and Al-Iraqi 2010; Dale and Haylett 2004).

Although the efficacy of anthelmintics against T. vitulorum infection in buffalo calves had been performed in different parts of the world like Indonesia (Satrija et al. 2011), Turkey (Avcioglu and Balkaya 2011), Egypt (Rizk et al. 2018) and Assam of India (Rajkhowa et al. 2003). Nevertheless, there are no reports on the efficacy of anthelmintics against T. vitulorum infection of buffalo calves in Bangladesh. Conversely, limited research has been conducted on the efficacy and resistance of anthelmintic on GI nematodes of cattle and small ruminants other than buffalo calves in the country (Dey et al. 2020; Islam et al. 2018; Sultana et al. 2015). Our recent study reveals a high prevalence (51.7%) of toxocarasis in buffalo calves of 1 to 3 months age in Bangladesh (Biswas et al. 2021) which emphasis the necessity to explore the efficacy of clinically used anthelmintics against naturally infected T. vitulorum. Geographic regions, seasons, age, poor health and buffalo calves with soft feces have been confirmed as potential determinates of toxocarasis in buffalo calves of Bangladesh from our recent study (Biswas et al. 2021).

Therefore, the present study was aimed to compare the efficacy of clinically used anthelmintics such as albendazole, levamisole and ivermectin against toxocarasis in buffalo calves and their effects based on the EPG counts, body weight gain and hematological parameters.

**Materials and methods**

**Ethical statement**

The study protocol was approved by the Animal Welfare and Experimental Ethical Committee (AWEEC) of Bangladesh Agricultural University (AWEEC/BAU/2018-11) and each procedure was performed under their guidelines.

**Study area and period**

The study was conducted in buffalo farms of coastal region at Charfassion upazila of Bhola district of Bangladesh (Fig. 1) for a period of successive 3 months from October to December 2020.

**Study design and animal data collection**

Thirty-two (32) naturally infected buffalo calves aged below 3 months were selected randomly based on the standard EPG counts (EPG 200) through the McMaster technique (Dorny et al. 2015; Thienpont et al. 1986). The animals were categorized into four groups viz., albendazole (ABZ), levamisole (LVM), ivermectin (IVM) as treated and control group (untreated). Each group comprises of eight buffalo calves irrespective of sex and buffalo types. The pretreatment and post-treatment fecal egg count of Toxocara infection, hematological parameters such as TEC (Total erythrocyte count), Hb% (Hemoglobin), PCV (Packed cell volume), ESR (Erythrocyte sedimentation rate) and TLC (Total leukocyte count), and body weight were recorded. The body weight of buffalo calves was calculated by previously described method (Samad 2001). In brief, the formula used for calculating the live weight of buffalo calves was \( W = \frac{L \times G^2}{300} \), where \( W \) is body weight in lbs, \( L \) is length of the calves from point of shoulder to pin bone in inches and \( G \) is the chest girth of
Fig. 1 Map of Bangladesh showing study area
the buffalo calves in inches. The final weight was converted into kilogram (kg).

**Fecal sample collection and examination**

Fecal samples were collected from both the treated and control groups of buffalo calves on day 0, day 14, and day 28 of treatment to measure the fecal egg count (EPG). Fecal samples were collected directly from the rectum, preserved in closed plastic zipper bags and labeled with unique identification numbers. The samples were kept in a cooled icebox and transported to the laboratory of the Department of Parasitology, Bangladesh Agricultural University (BAU), Mymensingh, and the samples were stored at 4°C until examination. The samples were then examined in the laboratory using the simple floatation technique and the EPG was counted by a modified McMaster technique on day 0, 14 and 28 of treatment (Soulsby 1968).

**Hematological examination**

Blood samples were collected aseptically from the jugular vein with a sterile syringe and needle. Three mL of blood sample was collected from each buffalo calve in an EDTA containing tube from the treated and untreated (control) groups on day 0 and 28 of treatment. The blood containing tubes were everted 2 to 4 times then kept in a cooled box and transported within 24 h to the laboratory of the Department of Physiology, Bangladesh Agricultural University, Mymensingh. The hematological parameters like hemoglobin content (Hb), packed cell volume (PCV), erythrocytes sedimentation rate (ESR), total erythrocyte count (TEC) and total leukocyte count (TLC) were determined as per the protocols described earlier (Coffin 1995).

**Fecal egg count reduction test (FECRT)**

All buffalo calves from both the treated and control groups were closely observed until day 28 of post-treatment. Three groups of buffalo calves were treated with each of ABZ and LVM @ 7.5 mg/kg body weight orally and IVM @ 0.2 mg/kg body weight (orally or injected) respectively, the fourth control group was remained untreated. Fecal samples were collected from each group of buffalo calves and the FECRT was performed according to the guidelines of the World Association for the Advancement of Veterinary Parasitology (WAAVP) (Coles et al. 1992; Levecke et al. 2012). The percentage of reduction of EPG was calculated using the previously described formula, \( N_1 - N_2 / N_1 \times 100 \), where, \( N_1 \) = number at day “0”; \( N_2 \) = number on next counting day (Levecke et al. 2012).

**Data analysis**

Data were analyzed using IBM SPSS, version 20. Primarily, the Kruskal–Wallis nonparametric ANOVA test was used to examine the assumptions, and the group homogeneity of calves, the fecal egg counts, body weight and hematological parameters of the pre-treated and post-treated buffalo calves with different categories of anthelmintic. One-way ANOVA with post hoc Duncan multiple comparison test was employed to identify whether there was a significant difference among the treated groups in comparison with the control group. Differences between means at \( p < 0.05 \) were considered as the level of significance.

**Results**

**Efficacy of anthelmintics based on FECRT**

The mean EPG of *Toxocara* in untreated control and all the treated groups were nearly similar at day 0 (pre-treatment). Based on the fecal FECRT, the mean EPG counts and efficacy of ABZ, LVM and IVM against toxocariasis from treated and control groups of buffalo calves are presented in Table 1 and Fig. 2. Following treatment with ABZ, LVM and IVM, the mean EPG was gradually reduced at day 14 and 28 of post-treatment and declined significantly (\( p < 0.01 \)) in all the treated groups at the end of the experiment. The reduction of EPG counts was higher in IVM followed by LVM and ABZ. FECRT reveals that 93.11% and 91.56% effectiveness of IVM and LVM at day 14 and 96.83% and 94.23% effectivity at day 28 of post-treatment, while ABZ showed low efficacy against toxocariasis with the FECRT of 70.61% at Day 14 and 85.84% at Day 28 of post-treatment, respectively.

**Efficacy of anthelmintics based on the hematological parameters**

**Hemoglobin (Hb) concentration**

The mean values of Hb (%) in the ABZ, LVM, IVM and control groups were 10.45 ± 0.14, 10.31 ± 0.12, 10.30 ± 0.12 and 10.82 ± 0.15 at day 0, respectively. On day 28 of treatment, the mean values of Hb (%) were significantly (\( p < 0.01 \)) increased to 11.00 ± 0.16, 11.12 ± 0.15 and 11.66 ± 0.12 among calves treated with ABZ, LVM and IVM respectively, although, it was decreased gradually to 9.93 ± 0.30 in the control group (untreated). However, the mean value of Hb (%) was highly significant (\( p < 0.001 \)) in buffalo calves treated with IVM (Table 2).
The pretreatment values of PCV in buffalo calves treated with ABZ, LVM, IVM and control group were 34.00 ± 1.92, 35.00 ± 0.49, 35.75 ± 0.31 and 35.37 ± 0.32, respectively. On Day 28 of post-treatment, the mean values of PCV were increased significantly (p < 0.05) to 36.00 ± 0.18, 37.43 ± 0.29 and 39.68 ± 0.24 in buffalo calves treated with ABZ, LVM and IVM, where, it was gradually decreased to 34.87 ± 0.22 on the day 28 of post-treatment in the control group. However, the increased mean value of PCV was highly significant (p < 0.001) in the calves treated with IVM and LVM (Table 2).

**Packed cell volume (PCV)**

Table 1: Efficacy of albendazole, levamisole and ivermectin on egg count (EPG) in buffalo calves based on faecal egg count reduction test (FECRT)

| Group | Anthelmintics | Pre-treatment | Post-treatment | **% Reduction at day 14 (95% CI)** | **% Reduction at day 28 (95% CI)** |
|-------|---------------|---------------|---------------|-----------------------------------|-----------------------------------|
|       |               | Day 0 Mean ± 1SEM | Day 14 Mean ± 1SEM |                                    |                                    |
| A     | Albendazole   | 1658.50 ± 908.98 | 466.75 ± 242.30 | 70.61 (48.40–92.81)               | 85.84 (72.25–99.43)               |
| B     | Levamisole    | 1500.12 ± 888.78 | 145.87 ± 76.09 | 91.56 (81.38–101.74)               | 94.23 (86.54–101.93)               |
| C     | Ivermectin    | 1534.0 ± 739.96  | 79.37 ± 42.29  | 93.11 (84.56–101.66)               | 96.83 (92.02–101.00)               |
| D     | Control group | 1613.25 ± 738.33 | 1317.37 ± 618.11| 18.57 (0–39.35)                   | 35.62 (6.65–64.58)                 |

1SEM, Standard error of mean; 1CI, Confidence interval; *p < 0.05; **p < 0.01 (According to one-way ANOVA with Post Hoc Duncan test)

a,b,c,d: In the same column, means with different superscripted letters are significantly different at p < 0.01

The pretreatment values of PCV in buffalo calves treated with ABZ, LVM, IVM and control group were 34.00 ± 1.92, 35.00 ± 0.49, 35.75 ± 0.31 and 35.37 ± 0.32, respectively. On Day 28 of post-treatment, the mean values of PCV were increased significantly (p < 0.05) to 36.00 ± 0.18, 37.43 ± 0.29 and 39.68 ± 0.24 in buffalo calves treated with ABZ, LVM and IVM, where, it was gradually decreased to 34.87 ± 0.22 on the day 28 of post-treatment in the control group. However, the increased mean value of PCV was highly significant (p < 0.001) in the calves treated with IVM and LVM (Table 2).

**Fig. 2** Effects of the tested anthelmintics on EPG against toxocariasis in buffalo calves

**Table 2** Effects of albendazole, levamisole and ivermectin on hematolgical parameters in control and study groups of buffalo calves

| Group | Anthelmintics | Hb (Mean ± 6SEM) | PCV (Mean ± SEM) | ESR (Mean ± SEM) | TEC (Mean ± SEM) | TLC (Mean ± SEM) |
|-------|---------------|------------------|------------------|------------------|------------------|------------------|
| Pre-treatment | | | | | | |
| A     | Albendazole   | 10.45 ± 0.14     | 34.0 ± 1.92      | 0.62 ± 0.18      | 5.50 ± 0.18      | 6.0 ± 0.18       |
| B     | Levamisole    | 10.31 ± 0.12     | 35.00 ± 0.49     | 0.56 ± 0.17      | 5.25 ± 0.16      | 5.58 ± 0.12      |
| C     | Ivermectin    | 10.30 ± 0.12     | 35.75 ± 0.31     | 0.62 ± 0.15      | 5.50 ± 0.18      | 6.12 ± 0.22      |
| D     | Control group | 10.82 ± 0.15     | 35.37 ± 0.32     | 0.56 ± 0.17      | 5.75 ± 0.16      | 6.0 ± 0.18       |

| Post-treatment | | | | | | |
| A     | Albendazole   | 11.00 ± 0.16**   | 36.00 ± 0.18*    | 0.18 ± 0.09*     | 5.93 ± 0.19*     | 5.37 ± 0.18**    |
| B     | Levamisole    | 11.12 ± 0.15***  | 37.43 ± 0.29***  | 0.12 ± 0.08**    | 6.06 ± 0.23**    | 5.62 ± 0.18**    |
| C     | Ivermectin    | 11.66 ± 0.12***  | 39.68 ± 0.24***  | 0.06 ± 0.06***   | 6.12 ± 0.35**    | 5.50 ± 0.18**    |
| D     | Control group | 9.93 ± 0.30      | 34.87 ± 0.22     | 0.87 ± 0.20      | 4.75 ± 0.16      | 6.37 ± 0.18      |

1Hb, Hemoglobin (gm %); 2PCV, Packed cell volume (%); 3ESR Erythrocyte sedimentation rate (mm in 1st hour); 4TEC, Total erythrocyte count (× 10^9/l of blood); 5TLC, Total leukocyte count (× 10^9/l of blood); 6SEM, Standard error of mean; *p < 0.05; **p < 0.01; ***p < 0.001 (According to one way ANOVA with Post Hoc Duncan test)
Erythrocyte sedimentation rate (ESR)

The initial estimated mean values of ESR (mm in 1st 1 h) were $0.62 \pm 0.18$, $0.56 \pm 0.17$, $0.62 \pm 0.15$ and $0.56 \pm 0.17$ in the buffalo calves treated with ABZ, LVM and IVM and control group, respectively. Following the treatment on day 28, the mean values of ESR (mm in 1st 1 h) were decreased significantly ($p < 0.001$) to $0.18 \pm 0.09$, $0.12 \pm 0.08$ and $0.06 \pm 0.06$ in the calves treated with IVM, LVM and ABZ; however, in the control group it was increased to $0.87 \pm 0.20$ at the end of the experiment (Table 2).

Total erythrocyte count (TEC)

The pre-treatment values of TEC ($\times 10^6$/μl of blood) were $5.50 \pm 0.18$, $5.25 \pm 0.16$, $5.50 \pm 0.18$ and $5.75 \pm 0.16$ in the buffalo calves treated with ABZ, LVM, IVM and control group, respectively. On the day 28 of post-treatment, the mean values of TEC were increased to $5.93 \pm 0.19$, $6.06 \pm 0.23$ and $6.12 \pm 0.35$ in the calves treated with ABZ, LVM and IVM, but in the control group, it was decreased to $4.75 \pm 0.16$ at the end of the experiment. The improvement of TEC counts was statistically significant ($p < 0.05$) in buffalo calves treated with IVM and LVM compared to the control group (Table 2).

Total leukocyte count (TLC)

The pre-treatment values of TLC ($\times 10^3$/μl of blood) were $6.00 \pm 0.18$, $5.58 \pm 0.12$, $6.12 \pm 0.22$ and $6.0 \pm 0.18$ in the calves treated with ABZ, LVM, IVM and control group, respectively. On day 28 of the post-treatment, the mean values of TLC were decreased to $5.37 \pm 0.18$, $5.62 \pm 0.18$ and $5.50 \pm 0.18$ in the buffalo calves treated with ABZ, LVM and IVM whereas it was started to increase $6.37 \pm 0.18$ in the control group. The decrease rate to normal value in the treated groups of calves was statistically significant ($p < 0.01$) and the calves treated with IVM and LVM was found to be highly significant ($p < 0.001$) (Table 2).

Effects of anthelmintics on body weight

The mean value of pre-treatment body weight of buffalo calves, treated with ABZ, LVM, IVM and control group were $34.47 \pm 0.51$, $35.98 \pm 0.49$, $36.10 \pm 1.05$ kg and $38.09 \pm 1.32$ kg, respectively. On day 28 of the post-treatment, the mean values of body weight were increased to $39.58 \pm 0.71$, $42.25 \pm 0.60$, $44.66 \pm 0.97$ and $38.92 \pm 1.23$ kg in the calves treated with ABZ, LVM, IVM and control group (untreated) respectively. Among the treated groups, the mean body weight improvement was found higher in the buffalo calves treated with IVM and LVM than buffalo calves treated with ABZ (Table 3).

Discussion

Toxocariasis is one of the pivotal parasitic diseases in tropical countries causing high mortality and morbidity in buffalo calves (Srivastava and Sharma 1981). Adult buffaloes are the source of infection, while suckling calves play a vital role in infection maintenance. The larvae do not mature into adults in adult animals and stay as third-stage larvae; whenever infected dams become pregnant, the larvae migrate from the liver to the mammary glands, where they infect suckling calves through milk (Avcioglu and Balkaya 2011). The larvae mature into adults after 3 to 4 weeks and begin shedding thousands of eggs in the feces of infected calves (Roberts 1990a, b). As a result, treating infected young calves is crucial for toxocariasis management. Anthelmintics are traditionally used in grazing livestock helminth control and to prevent productivity losses due to parasitic diseases. Since nearly last 4 decades, use of anthelmintic has been commonly practiced to achieve effective control programs against GINs infection (Silva et al. 2011; Ahid et al. 2008). In this regard, pyrantel, pyperazine, febantel, livamisole, oxendazole, fenbendazole, ivermectin and epimectin have exhibited efficacy against T. vitulorum infection in buffalo and cattle calves in different countries (Roberts 1989, 1990a, b; Davila 2010; Islam et al. 2005, Sultana et al. 2015). In Bangladesh, albendazole, Levamisole and Ivermectin are most commonly used anthelmintics for the treatment and control of gastro-intestinal nematodes in calves and small ruminants (Saiful et al. 2018). Therefore, searching for more efficacious anthelmintics is an urgent need. In the study, we performed FECRT according to the guidelines of the World Association for the Advancement of Veterinary Parasitology (WAAVP) in different commercial buffalo farms in Bangladesh. Data obtained from FECRT indicate that anthelmintics presented an efficacy (%) varied from low to high against ABZ, LEV and IVM, respectively. ABZ (Benzimidazole) is being used the most popular group of broad spectrum anthelmintics along with LEV (imidazothiazole) and IVM (macrocyclic lactones). In buffalo farms in Bangladesh, anthelmintic treatment is usually practiced without weighing the animals. Therefore, exposing the parasites to sublethal doses or over doses of the drugs possibly contributes largely to the loss of effic- cacy. We presume the situation is practically the same in all buffalo farms distributed throughout the country because they practice similar type of management and livestock husbandry practices.
Since, there is sparse of information regarding the efficacy of IVM, LVM and ABZ in buffalo calves and it is difficult to explain the exact cause of resistance. Although, the efficacy of ABZ, LVM and IVM have not been reported yet in buffalo calves, nevertheless, this study may act as a frontier of anthelmintic efficacy of ABZ, LVM and IVM against T. vitulorum infected buffalo calves in Bangladesh context. Our report revealed 96.83% efficacy of IVM followed by 94.23% LVM and 85.84%, ABZ. Anthelmintic treated calves showed significant \( (p < 0.01) \) increase in Hb, PCV, TEC and body weight and decrease in ESR and TLC as a result of worm expulsion from buffalo calves after 28 days of treatment. Among the tested anthelmintics, IVM was found highly effective against toxocariasis in buffalo calves. Regarding the animal of other species, a similar study report had been published on toxocariasis in buffalo calves (Ram et al. 2007).

On the other hand, a comparative study was conducted previously in India where IVM and LVM were reported mostly effective anthelmintics against the treatment of naturally infected ascariasis in crossbred cattle calves (Hafiz et al. 2010). The highest potency of ABZ and LVM were recorded elsewhere of the world against the treatment of gastro-intestinal nematode parasites in goats (Gill 1996; Ram et al. 2007).

During the analyses of hematological parameters, it was found that Hb, PCV and TEC of buffalo calves were significantly \( (p < 0.05) \) increased after treated with ABZ, LVM and IVM. In contrast, the ESR and TLC were significantly \( (p > 0.05) \) decreased in the treated groups of buffalo calves (Table 2) and it was highly significant \( (p < 0.001) \) in case of IVM treated calves. The mean value of Hb, PCV and TEC was decreased, whereas the ESR, TLC were increased in the control group. The findings of our present study indicate that IVM is more effective anthelmintics against the treatment of T. vitulorum infection in buffalo calves, followed by LVM. This finding discloses that IVM is still highly effective for the reduction of EPG of toxocariasis in buffalo calves (Table 1) in the studied areas. However, our findings are also consistent with the findings reported previously from the country and abroad (Amin et al. 2005; Mukherjee 1992; Nwosu et al. 2008; Sultana et al. 2015).

In case of body weight gain, the findings of our study showed that IVM was highly effective anthelmintic for body weight gain by reducing the EPG of T. vitulorum infection followed by LVM and ABZ. The body weight gain of buffalo calves was increased after treatment with IVM, LVM and ABZ which were similar to the earlier findings from Australia where Australian Friesian Sahiwal (ASF) heifers gained weight after treated with IVM, LVM and ABZ (Isles et al. 1985). The plausible cause of body weight gain may be due to the removal of parasitic burden, adequate absorption and metabolism of nutrients in the

### Table 3 Effects of albendazole, levamisole and ivermectin on body weight (kg) gain/loss of buffalo calves in various treatment days

| Group     | Anthelmintics  | Pre-treatment Day 0 | Post-treatment Day 28 | Live weight gain/loss (kg) | Improvement (%) |
|-----------|----------------|---------------------|-----------------------|---------------------------|-----------------|
| A         | Albendazole    | 34.47 ± 0.51        | 39.58 ± 0.71          | + 5.11                    | 14.82           |
| B         | Levamisole     | 35.98 ± 0.49        | 42.25 ± 0.60          | + 6.27                    | 17.42           |
| C         | Ivermectin     | 36.10 ± 1.05        | 44.66 ± 0.97*         | + 8.56                    | 23.71           |
| D         | Control group  | 38.09 ± 1.32        | 38.92 ± 1.23          | + 0.83                    | 2.28            |

\( *p < 0.05; **p < 0.01 \) (According to one way ANOVA with Post Hoc Duncan test)
parasite-free gastrointestinal tract after the treatment with anthelmintics. On the other hands, the body weight gain of buffalo calves was not increased in the control group which indicates that there may be heavy overload of parasites within the untreated group. Our findings are consistent with the earlier findings reported from Bangladesh (Sultana et al. 2015; Isalm et al. 2005) and abroad where the body weight of the tested calves increased after treatment with anthelmintics irrespective of animal species used in trial (Fornieles et al. 2000; Kaminsky et al. 2008; Kuzmina and Kharchenko 2008; Rajangam and Balachandran 1989; Ryan et al. 1997). The body weight gain of animal does not depend on parasitic infections. It may also be associated with many other factors like supply of adequate quality food, husbandry, management and other stressors which could not be controlled here (Sarkar et al. 2005). From this study, it is suggested that buffalo calves should be routinely monitored through fecal examination especially on the first 2 weeks for the presence of *T. vitulorum* eggs and should be treated with the most effective anthelmintics in order to expel the worms as well as restore the calf health. During conducting the trial, the clinical signs were not typical in infected calves such as constipated or diarrheic and the dosages of anthelmintics drugs were maintained by following the manufacturer’s instructions. In the present study, the reduction of efficacy of anthelmintics may be explained by the management practices on the farm which have reduced the level of refugia. The most accurate method to evaluate the anthelmintic efficacy is the test and slaughtered methods (Aiello and Mays 1998). A similar study was performed on a small number of animals and revealed 100% reduction of worm burden at 14 days after treatment with ivermectin (Chompoochan et al. 1998).

**Conclusion**

The present study revealed that IVM (96.83%) was the most effective drug against toxocariasis in buffalo calves followed by LVM (94.23%) under field condition. The results of the study indicate that IVM and LVM have significant effects on the EPG, hematological parameters (Hb%, PCV, ESR, TEC and TLC) and body weight against ascariasis in buffalo calves than that of ABZ alone during the experiment. The efficacy of ABZ was comparatively low (85.84%) in the treated buffalo calves. The present findings may be a landmark for further detailed study related to prevention, control measures and status of anthelmintic resistance against *T. vitulorum* infection in buffalo calves. Further, studies are required to understand the efficacy of anthelmintics in different agro-ecologies, buffalo management systems, different animal species and in vitro test followed by egg hatch assay (EHA) in *T. vitulorum* infection in buffalo calves in Bangladesh.

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**Declarations**

**Conflict of interest** The authors declare that they have no conflict of interest exists. The authors are solely responsible for the content and writing of the report.

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