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Comparative Study of Herbal Feed Additives on Growth Performance and Haematology in Female Dairy Calves

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ABSTRACT

Herbal feed additives, including turmeric (*Curcuma longa*), garlic (*Allium sativum*), and ginger (*Zingiber officinale*), are increasingly explored for their potential to enhance livestock performance. **Objective:** To evaluate the effects of *Curcuma longa* (Turmeric), *Allium sativum* (Garlic) and *Zingiber officinale* (Ginger) powder on the growth performance and hematological values of cross-bred female cow calves. **Methods:** : This experimental study was conducted from June, 2024 to October, 2024.The experimental groups were fed with standard rations and different concentrations of feed additives, i.e. 0.5 %, 1% and 1.5% of calf starter for sixteen weeks. An automated haematology analyzer was used to carry out haematological studies. **Results:** This study revealed a significant increase in weight gain along with PLT counts by the calves fed with *Allium sativum* (Garlic) powder at varying concentrations of 1.5 %, 0.5 % and 1.0 % calf starter, respectively. Haematological analysis showed substantial improvement in RBCs/WBCs/PLT counts and Hb/HCT levels in calves receiving 1.5% Curcuma longa (Turmeric) powder. No significant increase in growth rate was observed in any group fed with *Zingiber officinale* (Ginger) as a feed additive. **Conclusions:** On the basis of findings of this study, the use of 1.5 % *Allium sativum* (Garlic) as feed additive along with standard diet for increased weight gain in dairy calves is recommended. The addition of 1.5 % Curcuma longa (Turmeric) as feed additive in the diets of dairy calves also leads to increased count of RBCs, Hb, HCT, PLT and WBC's values resulting into better immunity and resistance.

INTRODUCTION

Nutrition is critical to the growth and overall health of animals, particularly in their early stages of life. Cow calves require adequate nourishment for healthy growth and the development of strong immunological and haematological systems. Traditionally, synthetic feed additives have been employed to increase cattle production; however, there is increased interest in the use of herbal feed additives due to their natural origins and possible health benefits. Research on early life nutrition is increasingly recognized as vital, given that optimizing the development of healthy dairy calves is essential for ensuring long-term financial sustainability in dairy farming. The period of growth between birth and weaning is extremely important for economic farming [1, 2]. Early life growth rate has long-term impacts on age at first calving, future milk output, and lifespan [3]. Calves are vital to future dairy herds, and maintaining optimal growth and early puberty is critical to their development. While milk-feeding boosts weight gain, lowers sickness, and encourages natural behavior, it is not economically viable as a primary diet. Growth, rumen development, feed efficiency, and overall dairy performance are all highly impacted by weaning techniques [4]. Feed is an essential component for calves as it accounts for 60–70% of production expenses. Hormones and antibiotics were formerly used to boost growth, but the demand for substitute feed additives has grown due to concerns about their use. Medicinal plants and their derivatives, known as phytobiotics, can positively

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improve animal rumen fermentation, performance, and overall health, depending on the individual components revealed that phytogenic are a group of natural growth promoters or non-antibiotic growth promoters used as feed additives, derived from herbs, spices or other plants [5, 6]. Positive results during the suckling period have been found in recent research on the use of herbal supplements in ruminants [7-9] noted that using herbal formulas as a supplement could lead to feeds that don't contain antibiotics. During the nursing period, herbal extracts can maintain or improve calf health and productive parameters [10, 11]. In dairy and cattle production systems, herbal formulations are being researched as a means of increasing feed efficiency and as an alternative to antibiotics during illness [12-14]. Garlic (*Allium sativum*) is being used as a spice and traditional medicine with a high nutritional value. It is a rich source of calcium and phosphorus and also has high carbohydrate content [15]. The active components comprise of allicin (dialthiosulfinate), and n-acetyl cysteine. Garlic promotes vasodilation and nitric oxide activity, which helps to reduce blood pressure which has also been reported in several studies. Current research has revealed that garlic has antibacterial, antifungal, antioxidant, anticancer and antidiabetic effects. Turmeric (*Curcuma longa*) is frequently utilized in Asian cuisines and traditional medicine as it is an herbaceous spice. It is also well-known for its vivid color, added to food as a stabilizing and coloring agent [16]. Turmeric consists of advantageous phenolic compounds such as Curcumin, bisdemethoxycurcumin, and demethoxycurcumin due to which it's referred as strong antioxidant, nematocidal, anti-inflammatory, anti-carcinogenic, and anti-hepatotoxic qualities [17-22]. Ginger (*Zingiber officinale*) is a extensively used herb with anthelmintic properties which have been studied in invitro and in vivo experiments [23-26]. It's a popular culinary spice and medicinal plant [27]. Ginger is also known for its antioxidant, antibacterial, antiviral, anthelmintic, and anti-diabetic properties [28]. During drying process of ginger, a potent compound called Shogaol is formed which contributes to its medicinal effects, including both antineoplastic and anti-inflammatory benefits [29, 30] Studies have indicated that these herbs may positively influence growth performance and health in livestock, yet there is limited research specifically focusing on their effects on cow calves. This study aims to evaluate the effects of turmeric, garlic, and ginger powders as economical and natural feed additives on the growth performance and hematological profiles of crossbred female cow calves over an 8-week period. Understanding the effects of herbal feed additives could offer a natural alternative to synthetic supplements, potentially leading to improved health and productivity in dairy cattle. This research holds significance not only for enhancing livestock management practices but also for advancing sustainable and health-conscious approaches in animal husbandry.

METHODS

Procurement of the Feed Additives

Fresh garlic (*Allium sativum*), turmeric (*Curcuma longa*) and ginger (*Zingiber officinale*) powder were obtained from local market and then dried. After drying the husks were separated and the bulbs were ground to powder by electric grinder.

Study Design

This experimental study was conducted from June, 2024 to October, 2024, to evaluate the effects of turmeric (*Curcuma longa*), garlic (*Allium sativum*) and ginger (*Zingiber officinale*) as feed additives on the growth performance and hematological parameters of female cow calves. A total of 50 cross bred female cow calves, 8 weeks old having uniform body weight (24 Kg) from a local dairy farm were selected for this study. These calves were divided in ten groups comprising of one control and three experimental groups. Group A was considered as control and B, C and D were experimental containing fifteen calves in each group. Group B, C and D will be further divided into three sub groups as B1, B2, B3, C1, C2, C3, D1, D2 and D3. Each sub group will comprise 5 experimental calves. Control group was given standard feed without any feed supplement. The experimental groups were as follows:

Group B1, B2 and B3 were given standard feed with addition of Curcuma longa at the rate of 0.5%, 1%, 1.5 % of total quantity of calf starter respectively.

Group C1, C2 and C3 were given standard feed with addition of *Allium sativum* at the rate of 0.5%, 1%, 1.5 % of total quantity of calf starter respectively.

Group D1, D2 and D3 were given standard feed with addition of *Zingiber officinale* at the rate of 0.5%, 1%, 1.5 % of total quantity of calf starter respectively.

Feeding Schedule and Calculations

Each calf was provided with accurately weighed feed twice daily, once in the morning and once in the evening. Clean drinking water was offered ad- libitum throughout eight weeks.

The standard feed provided to each calf, at different stages of age has been detailed in table 1.

Table 1: Sample Collection from Caged and Free-Living Avian Species

Age (Weeks)	Milk Replacer (Lit)	Calf Starter (Kg)	Concentrate (Kg)	Green Fodder (Kg)
9	5	1.30	-	1.05
10	4	1.60	-	1.05
11	4	1.80	-	1.05
12	3	2.10	-	1.20

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13	3	2.40	-	1.20
14	2	2.50	0.1	1.20
15	2	2.60	0.2	1.20
16	2	2.70	0.3	1.20

Growth Performance Evaluation

The calves were individually weighed at weekly intervals to monitor their growth performance. Data were collected and calculated as follows: Body Weight Gain (BWG) = Final weight -Initial weight.

Hematological Investigation

Blood samples were collected from control and experimental groups on 16th weeks age. A total of 1.5 ml blood was drawn from jugular vein of all the calves using sterile plastic syringe. It was transferred to sterile EDTA coated vials and transported under refrigeration to research lab of Lahore Garrison University. Samples were labelled properly and samples were processed in three replicates for control and experimental groups. Automated hematology analyzer (BIOBASE Auto Hematology Analyzer Model BK- 5000 Jinan, China) was used to carry out hematological studies.

Statistical Analysis

Data was analyzed using one-way ANOVA with IBM SPSS. LSD test was employed to compare variances within means at the significance level of $P<0.05$.

RESULTS

Growth Performance

At the end of the 16th week of the trial, it was observed that the live body weight (kg) of crossbred female cow calves receiving 1.5% Allium sativum powder supplementation, along with standard feed, showed a highly significant increase as compared to the control group. This suggests that the Allium sativum supplementation had a strong positive effect on growth performance. Additionally, calves fed with 1.5% Curcuma longa powder also exhibited a significantly positive effect on their growth rate. This indicates that Curcuma longa supplementation was effective in enhancing growth performance as well. In contrast, calves receiving 0.5% Allium sativum and varying concentrations (0.5%, 1%, and 1.5%) of Zingiber officinale showed a significantly negative effect on their growth rate. This suggested that these treatments were not effective in promoting growth and might have had a detrimental impact. The weekly body weight gains of the control and experimental groups are further illustrated in figure 1.

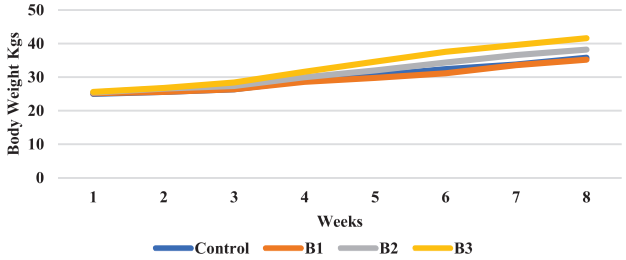

Figure 1: Comparison of Weekly Body Weight Gain of Control and Experimental B Group of Calves

In figure 2 the experimental groups supplemented with *Allium sativum* (C1, C2, C3) exhibited improved growth performance compared to the control group. Among these, C3 (1.5% *Allium sativum*) showed the most significant weight gain, reaching 47.8 kg by the end of the study period. These results highlighted the effectiveness of Allium sativum as an herbal feed additive for enhancing growth in crossbred female cow calves.

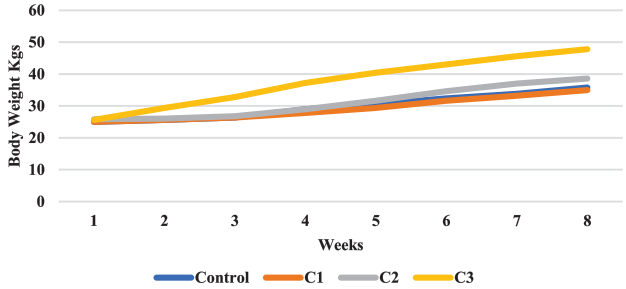

Figure 2: Comparison of Weekly Body Weight Gain of Control and Experimental C Group of Calves

In figure 3, the experimental groups supplemented with *Zingiber officinale* (D1, D2, D3) displayed less pronounced growth. Minimal improvements were observed compared to the control group, indicating the limited effectiveness of *Zingiber officinale* in promoting weight gain in crossbred female cow calves.

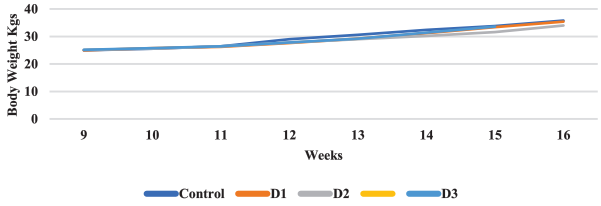

Figure 3: Comparison of Weekly Body Weight Gain of Control and Experimental D Group of Calves

Table 2 revealed that 1.5% *Allium sativum* (C3) and 1.5% Curcuma longa (B3) significantly increased body weight compared to the control, with p-values of 0.000 and 0.0002, respectively. In contrast, other groups, including those with *Zingiber officinale* and lower doses of *Allium sativum* and *Curcuma longa*, showed no significant differences or negative effects. At the end of 16th week age, the total body weight gains of all groups indicated maximum gain by C3 followed by B3 and C2 groups.

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Table 2: Statistical Comparison of All Experimental Groups Body Weight with Control Group

Groups	Groups	Difference	Standard Deviation	Mean ± SEM	p-Value
Control	B1	0.600	1.3038	35.2 ± 0.58	1.000
	B2	-2.400	1.3038	38.2 ± 0.58	0.513
	B3	-5.800*	1.8166	41.6 ± 0.81	0.0002
	C1	0.800	1.0000	35.0 ± 0.44	0.999
	C2	-2.800	2.7928	38.6 ± 1.24	0.302
	C3	-12.000*	1.3038	47.8 ± 0.58	0.000
	D1	0.400	1.3416	35.4 ± 0.60	1.000
	D2	1.800	1.5811	34.0 ± 0.70	0.839
	D3	0.200	2.0736	35.6 ± 0.92	1.000

Hematology

The hematological values of red blood cells (RBCs), Hemoglobin (Hb), hematocrit (HCT), platelets (PLT) and white blood cells (WBCs) of all the calves of control and experimental groups obtained at sixteen-week age using automated hematology analyzer (BIOBAE).

RBCs

In figure 4 at the end of the 16th week, the RBC values showed the greatest increase in the B3 group, followed by D3 and C2. The 1.5% Curcuma longa feed additive demonstrated significant positive effects on the RBC count in crossbred female cow calves. Additionally, a notable increase in RBC values was observed in calves fed with 1.5% *Zingiber officinale* and 1% *Allium sativum*.

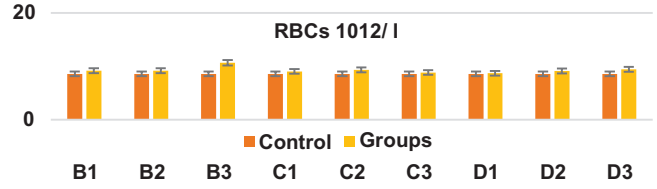

Figure 4: Comparison of RBC Values in Control and Experimental Groups of Calves

Hemoglobin

Significant (P<0.05) positive effects have been observed on the number of Hb values of crossbred female cow calves fed with 1.5% *Curcuma longa* as feed additive. The use of 1.5% *Curcuma longa* as feed additive resulted into improved number Hb values as shown in the figure 5. At the end of the 16th week, the Hb values showed the greatest increase in the B3 group, followed by C2 and C1.

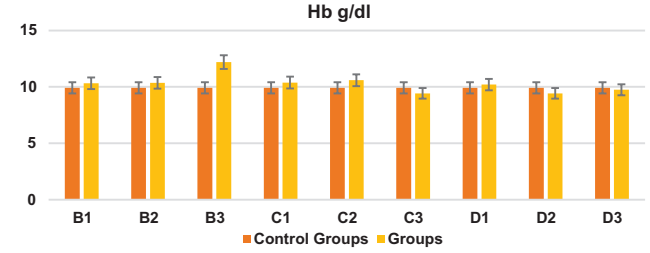

Figure 5: Comparison of Hb Values in Control and Experimental Groups of Calves

HCT

As shown in the figure 6, B3 group of experimental calves fed with 1.5% Curcuma longa powder is highly significant (P<0.05).

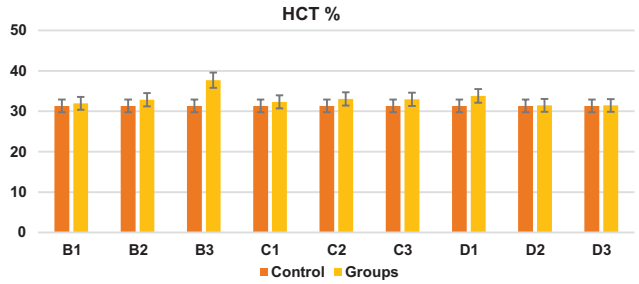

Figure 6: Comparison of HCT Values in Control and Experimental Groups of Calves

PLT

It was observed that B3 group of experimental calves fed with 1.5% *Curcuma longa* powder is highly significant (P<0.05) and resulted into increased number of PLT values. A significant positive effect in the calves fed with 1 % and 0.5 % Curcuma longa powder was also noticed. At the end of the 16th week, the PLT values demonstrated the greatest increase in the B3 group, followed by C2 and C1 (Figure 7).

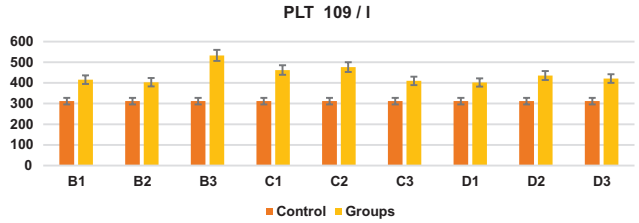

Figure 7: Comparison of PLT Values in Control and Experimental Groups of Calves

WBCs

Figure 8 showed that WBCs of experimental group of calves B3 fed with 1.5 % Curcuma longa powder have highly significant (P<0.05) effect and have assumed unequal variances. WBC's of B2, C3 and D2 experimental group of calves have insignificant effect and have assumed equal variances. At the end of the 16th week, the WBC values showed the greatest increase in the B3 group, followed by C1 and D1.

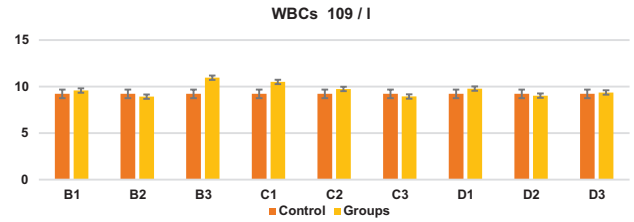

Figure 8: Comparison of WBC Values in Control and Experimental Groups of Calves

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DISCUSSION

The use of herbal feed additives in dairy calf nutrition gained attention in recent years as a potential strategy to improve growth performance and overall health. While research on herbal feed additives for dairy calves was ongoing to ensure calf growth, it remained important to provide them with a balanced diet that met their nutritional requirements. High-quality calf starter feed, proper colostrum intake, access to clean water, and appropriate management practices ensured comfort and were key factors in promoting healthy growth and development in calves. The present study targeted novel herbal feed additives to be used in calf feed while keeping the rest of the factors standardized. The effects of different concentrations (0.5%, 1%, and 1.5% of feed) of Curcuma longa, Allium sativum, and Zingiber officinale were studied for their impact on the growth performance and hematological values of crossbred female cow calves. The results demonstrated a highly significant ($P<0.05$) increase in weight gain in C3 (Allium sativum at the rate of 1.5%), followed by B3 (Curcuma longa at the rate of 1.5%) experimental groups of crossbred female cow calves. Similarly, RBC and WBC counts, Hb, and HCT content of experimental group B3 (fed with 1.5% Curcuma longa powder) showed a highly significant positive ($P<0.05$) effect. In contrast, the PLT count of experimental groups B3 (fed with 1.5% Curcuma longa powder), C1 (Allium sativum at the rate of 0.5%), and C2 (Allium sativum at the rate of 1.0%) exhibited a highly significant positive ($P<0.05$) effect. The results of the present study provided compelling evidence for the positive effects on the growth rate and hematological values of crossbred female cow calves. These findings demonstrated a direct correlation between the growth rate of calves and the use of 1.5% Allium sativum as a feed additive. The use of 1.5% Curcuma longa as a feed additive also resulted in an improved number of RBCs, Hb, HCT, PLT, and WBC values. In agreement with these findings, it was found that the improvement in body weight gain was caused by the addition of garlic powder in feeding practices [13]. According to previous research, garlic had a high nutritional value, was a rich source of calcium and phosphorus, and contained high levels of carbohydrates [31]. This aligned with the present study, where the positive effect of 1.5% Allium sativum as a growth promoter was observed. Supporting evidence suggested that garlic had the ability to improve growth rate, digestibility, and carcass traits in livestock production as an alternative growth promoter. It was reported that alliinase enzymes were the main components of garlic [17, 32]. Additionally, garlic was found to control infectious diseases and was used to prevent wound infections. In agreement with this study, the increased PLT count observed in the study indicated its role in early wound healing through blood clotting. Evidence supported the fact that regular consumption of garlic could reduce factors associated with cardiovascular diseases. Similarly, turmeric powder was reported to increase nutrient utilization in female crossbred calves during the winter season, whereas garlic powder supplied at 15g/day per calf in the diet improved growth performance and reduced feed costs [33]. This study also revealed that the use of 1.5% turmeric powder and 1.5% garlic powder had a positive effect on hematology and overall body weight gains up to sixteen weeks of age. These findings were in total agreement with investigations by Balamurugan et al. (2014), who revealed that crossbred calves receiving garlic supplements gained considerably more overall body weight and average daily gain. It was reported that natural growth promoters such as garlic and ginger might be potential alternatives to commonly used chemical growth promoters like antibiotics [23]. However, in contrast to this study, the results revealed that the use of 0.5% garlic powder and 0.5%, 1%, and 1.5% ginger powder had no positive effect on the overall body weight of calves. It was reported that supplementation of garlic in crossbred calves increased average daily gain by 5.20% [34]. The increased average daily weight gain values observed in these findings suggested the positive role of garlic in growth performance. It was demonstrated that turmeric oil supplementation had a significant impact on all hematological parameters, including packed cell volume, hemoglobin, red blood cell count, mean corpuscular volume, mean corpuscular hemoglobin, mean corpuscular hemoglobin concentration, white blood cells, and their differentials [35]. In this study, supplementation with 1.5% turmeric powder resulted in an improved number of RBCs, Hb, HCT, PLT, and WBCs, thus having a significant positive effect on the hematology of crossbred female cow calves. According to Oyebanji et al. (2018), a diet supplemented with 10g/kg of turmeric was associated with considerably lower levels of total cholesterol, greater levels of high-density lipoprotein, and lower levels of low-density lipoprotein when compared to the control group. The study revealed improved hematology. Thus, improved hematological values coupled with lower blood cholesterol levels were expected to contribute to the good health of future herds. This study noted that the use of 1.5% turmeric powder resulted in an increased number of RBCs, Hb, HCT, and WBCs. These findings were endorsed by previous studies, which demonstrated that dietary

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supplementation with turmeric oil lowered cholesterol levels. It was reported that exposure to fenvalerate significantly decreased RBC counts, TLC counts, differential counts, PCV percentage, hemoglobin percentage, PCV, neutrophils, eosinophils, and monocyte levels. However, after turmeric treatment, there was a significant increase in these levels [36, 37], which aligned with the findings of the present study. In accordance with previous research, the concentration of platelets, hematocrit, monocytes, lymphocytes, and granulocytes increased significantly at 0.25% supplementation of Curcuma longa [38]. This study noted that the use of Curcuma longa powder at 1.5% as a feed additive significantly increased the total count of RBCs, hematocrit, platelets, and WBCs. This study was also in agreement with [23], who reported that Curcuma longa could enhance biochemical and hematological parameters in domestic animals when used as a feed additive. It was proposed that taking Curcuma longa at 50, 100, or 200 mg/kg body weight for the duration of the trial might improve hematological markers and overall health [39]. The study demonstrated the significant effect of 1.5% Curcuma longa powder in regulating blood parameters. These results contrasted with previous studies, which found that herbs like ginger had biological benefits, including promoting growth and stimulating the immune system [40-41]. In this study, the use of 0.5%, 1%, and 1.5% ginger powder did not show any significant effect on weight gain and hematological parameters compared with the control group. The reason might have been the use of different concentrations by the researchers. Although there was some evidence suggesting potential benefits, further studies were needed to determine the most effective herbal feed additives, optimal dosage levels, and their long-term effects on calf growth, health, and milk production.

CONCLUSIONS

Supplementation with herbal feed additives is proven to be a potential strategy to improve growth performance and blood parameters of calves. These additives offer several potential benefits to farmers for increased profitability. The use of economical herbal feed additives in appropriate concentration may lead to improved growth performance and overall health. On the basis of findings of these study the feeding of Allium sativum (Garlic) powder at the rate of 1.5 % of the total quantity of calf starter fed to female cross bred cow calves between 8 to 16 weeks of age has a positive effect on the body weight gain. The feeding of Allium Sativum (Garlic) powder at the rate of 0.5 % and 1 % of the total quantity of calf starter fed to female cross bred cow calves between 8 to 16 weeks of age has a positive effect on the PLT counts The feeding of 1.5% Curcuma longa (Turmeric) powder at the rate of 1.5 % of the total quantity of calf starter fed to female cross bred cow calves between 8 to 16 weeks of age has a positive effect on the RBCs, Hb, HCT, PLT and WBCs counts.

Authors Contribution

Conceptualization: FJ, MJK
Methodology: TZ
Formal analysis: HR
Writing, review and editing: TZ

All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

All the authors declare no conflict of interest.

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