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Effect of Supplementation Garlic Powder (*Allium sativum*) in the Growth Parameters of Sahiwal Calves

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ABSTRACT

The present experiment was conducted at Sahiwal Cattle Farm, College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati, Assam, India for a period of 120 days from July to November, 2022. to investigate the effect of supplementing garlic powder (*Allium sativum*) on the performance of Sahiwal calves. Twelve healthy Sahiwal calves of both sexes of similar age and body weight were allocated to two experimental groups, control and treatment with six animals in each group. Calves of both groups were fed with a standard basal diet consisting of concentrate, green fodder, and paddy straw. While in the treatment group, garlic powder was supplemented @ 250 mg kg^{-1} body weight along with concentrate feed. The experiment was conducted as a feeding trial for eight fortnights and a digestibility trial thereafter for five days in the two experimental groups. The statistical analysis revealed a highly significant differences ($^{**}p<0.01$) in body weight of the calves, fortnightly body weight gains up to 8th fortnight and the dry matter intake of the calves. Statistical analysis also revealed highly significant ($^{**}p<0.01$) differences in the conformation traits when compared between the groups with highly positive correlation with the body weight of the calves. Further it can be concluded that the supplementation of garlic powder at dosage of 250 mg kg^{-1} body weight in the Sahiwal calf ration is beneficial in terms of body weight gain, feed conversion ratio, body confirmation traits, and economic of feeding.

KEYWORDS: *Allium sativum*, garlic, Sahiwal calves, growth performance

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Data Availability Statement: Legal restrictions are imposed on the public sharing of raw data. However, authors have full right to transfer or share the data in raw form upon request subject to either meeting the conditions of the original consents and the original research study. Further, access of data needs to meet whether the user complies with the ethical and legal obligations as data controllers to allow for secondary use of the data outside of the original study.

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1. INTRODUCTION

Calves are the future replacement stock of the herd. In dairy cattle, the efficiency primarily depends upon the animal's feed and fodder supply, conception rate, and scientific management. Calves have to be nourished well in their early phases of life as the development rate is accomplished right from the day of conception. The addition of antibiotics to animal feeds has been widely used to promote growth performance, the feed conversion rate, product quality and animal health (Ran et al., 2018 and Wu et al., 2020). However, indiscriminate use of antibiotics result in microbial resistance to drugs and antibiotic residue in edible animal products attracting significant public concern (Do et al., 2019 and Lan et al., 2020). A more recent development is the use of herbs and its supplementation can improve animal performance, health and product quality (Tao et al., 2020).

Garlic (*Allium sativum* L.), native to Central and South Asia, is an annual bulbous herb of the Alliaceae family. Approximately 27 mt of garlic are produced worldwide each year, with China, India, South Korea, Egypt and the USA being the top five garlic-producing countries (Lee et al., 2020 and Rouf et al., 2020). Garlic and its products are rich in bioactive organosulphur compounds which give garlic products many medicinal and physiological properties (Qin et al., 2020). A number of garlic preparations are available on the market as natural health products for humans, including garlic powder, essential oils, extracts and capsules (Botas et al., 2019). Dietary supplementation with garlic products has shown some beneficial effects on the growth performance and product quality of monogastric animals (Ogbuewu et al., 2019 and Yan et al., 2011). Garlic products are also used to manipulate the rumen ecology to achieve better growth performance, reduce methane emissions, and improve the quality of ruminant products (Curry and Whitaker, 2010 and Ogbuewu et al., 2019). Moreover, garlic products have a variety of biological benefits to ruminants (Yang et al., 2021, Zafarian and Manafi, 2013). The dietary addition of garlic powder not only increases the digestibility of DM, crude fibre, crude protein (CP), nitrogen-free extracts and organic matter, but also improves the average daily gain (ADG) and feed conversion ratio (FCR) of lambs (Kewan et al., 2021, EI-Naggar and Ibrahim, 2018, Zhong et al., 2019 and Meena, 2018). Dietary supplementation with garlic products is can influence the diversity of the rumen microbiota, leading to changes in the rumen fermentation pattern, inhibition of methane emissions, more effective utilization of nutrients, improved growth performance of ruminants, and finally, improved quality of ruminant products (Ding et al., 2023).

Addition of herbal plant mixtures increased ADG, starter feed intake, and serum BHB concentration in dairy calves and also has some beneficial effects during the suckling period in ruminants (Seifzadeh et al., 2017, Crosby et al., 2017 and Roque-Jiménez et al., 2020) and also lead antibiotic-free feeds (Assan, 2018, Frankic et al., 2009 and Wall et al., 2014). In dairy and beef production systems, there is interest in using herbal formulas as alternatives to antibiotics during disease (Mendoza et al.,2019) and as enhancers of feed efficiency (Wall et al., 2014). Herbal formulas have mainly aimed to modify rumen fermentation and improve nutrient utilization in ruminant production (Frankic et al., 2009). In ruminant livestock production, herbal formulas have been reported to have positive effects stimulating a non-specific immune response (Kumar and Pandey, 2014), epigenetic changes (Roque-Jiménez et al., 2020), antioxidant effects (Toghyani et al., 2015), inhibiting replication of specific pathogenic microorganisms (Rivera-Méndez et al., 2017), stimulating the immune response or providing nutrients with or without nutraceutical properties.

2. MATERIALS AND METHODS

2.1. Location and period of study

The research was carried out at Sahiwal Cattle Farm, College of Veterinary Science Khanapara, Assam Agricultural University, Khanapara, Assam, India. The experiment was conducted for a period of 120 days from July to November, 2022. The farm is in a plain area where the water source mainly depends on rainfall and bore wells. The farm is situated at 26.1213° N latitude, 91.8216° E. In Khanapara, during the entire year, the rain falls for 197.8 days and collects up to 1663 mm (65.47") of precipitation. The temperature here typically varies from 53°F to 89°F.

2.2. Experimental animal and design

Twelve healthy Sahiwal calves were selected randomly and divided into two groups viz. Control (To) and Treatment (T_1) consist of 6 animals (5-6 months of age) in each group with equal number of both sexes (Table 1). The initial body weight of T_0 (81.81 kg) and T_1 (81.46 kg) did not differ significantly.

2.3. Management and feeding of animals

All the experimental calves were housed in a close shed with a provision for individual feeding and watering facilities.

Table 1: Distribution of animals in different treatment groups

Groups	No. of animal	Treatment
Control (T_0)	6	Without feeding Garlic
Treatment (T_1)	6	Feeding Garlic @ 250 mg kg^{-1} body weight with concentrate mixture

The animals were allowed to exercise 1 hour daily morning and afternoon in the open paddock. All the calves were provided a mixer of green grasses (Para, Napier and Guinea grasses) and paddy straw as basal diet *ad libitum* twice daily. The standard concentrate ration consisting of DCP: 17.27% and TDN: 73.67% offered twice daily. The animals were fed individually from the manger tying with a rope. The feeding was done as per the feeding regimn of ICAR, 2013. Along with the feed, each calf of the treatment group (T_1) were supplemented with Garlic powder @ 250 mg kg^{-1} body weight in concentrate feed.

2.4. Recording of data

2.4.1. Body weight (kg)

Body weights of the experimental calves were recorded at the beginning of the experiment and subsequently at fortnightly intervals till the end of the experiment with the help of a platform balance.

Fortnightly body weight gain=Body weight at the end of the fortnight - Body weight at the beginning of the fortnight.

Average daily body weight gain =(Final body weight-Initial body weight)/No. of days in the experiment

2.4.2. Daily feed intake (DM basis)

Total amount of feed offered to the calves was recorded. Residual feed of 24 hours was collected daily. Dry matter intake (DMI) of total feed consumed was calculated by subtracting the DM of residual feed from the DM of feed offered daily

2.4.3. Feed conversion ratio

The feed conversion efficiency/ratio was estimated on a dry matter basis. The FCR was calculated by using the following formula:

Feed conversion ratio=Dry matter intake (kg)/ Body weight gain (kg)

2.4.4. Body length (cm)

The body length of the calves was measured on either side of the calve from the point of shoulder to the point of pin bone then the average was noted.

2.4.5. Chest girth (cm)

The chest girth was measured as the circumference of the body just over the chest of the calf immediately behind the point of elbow.

2.4.6. Height at wither (cm)

It was taken as the distance from the highest point of the wither to the ground.

2.4.7. Statistical analysis

Two-way analysis of variance with interaction was done to test the significance of the difference in the treatment means to arrive at a conclusion as per methods prescribed by Snedecor and Cochran (1991).

3. RESULTS AND DISCUSSION

3.1. Growth performance

3.1.1. Body weight (kg)

The results of the analysis of variance revealed significant ($^{**}p<0.01$) difference on fortnightly body weight between the control (T_0) and treatment (T_1) groups. Significant increase in body weight were recorded from 2nd to 8th fortnight in garlic supplemented group (T_1) The Different average body weight (kg) of the calves in the control group (T_0) and treatment (T_1) groups were 87.56±0.34 and 88.11±0.35 kg, 94.04±0.36 and 95.19±0.36 kg, 101.14±0.38 and 102.91±0.30 kg, 109.03±0.40 and 111.48±0.32 kg, 117.69±0.38 and 120.82±0.34 kg, 127.25±0.41 and 131.03±0.37 kg fortnight, 137.63±0.41 and 142.13±0.40 kg and 148.75±0.40 and 153.84±0.38 kg at 1st, 2nd, 3rd, 4th, 5th, 6th, 7th and 8th fortnight. The result of the present investigation suggests that the increase in body weight gain of Sahiwal calves may be because of organosulphur compounds of garlic such as allicin, S-methylcystein sulfoxide, S-allycystein, and diallyl disulfide having antimicrobial activity resulting into the improved gut environment and in turn causes improved efficiency of utilization of nutrient and enhanced growth (Cullen et al., 2005).

Keeping conformity with the present findings, Balamurugan et al. (2014) reported that supplementing garlic powder at the dose rate of 250 mg kg^{-1} to body weight to Jersey crossbred calves in water and concentrate feed showed highly significant ($^{*}p<0.05$) body weight gain than to a non-supplementing group. Jagota et al. (2021) also reported that the average daily gain was statically similar in crossbred calves, but numerically 5.23% increased ADG was observed in the garlic fed group.

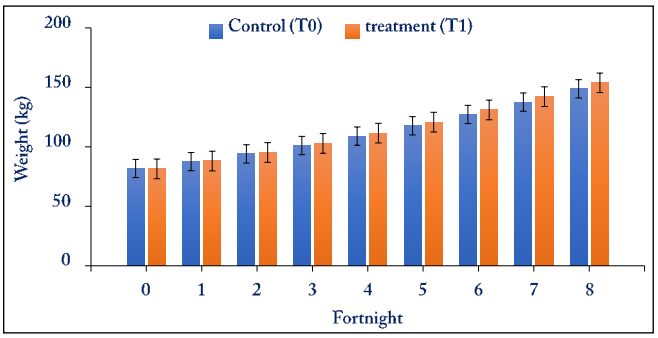

Figure 1 : Graphical representation of average fortnightly body weight (kg) of Sahiwal calves during the experimental period

3.1.2. Daily body weight gain (g)

The result of currant study showed significant difference in average daily body weight gain of Sahiwal calves supplemented with garlic powder (T_1) over non supplemented group (T_0). The overall mean values of daily body weight gains were 558±17.00 and 603±17.00 kg in T_0 and T_1 groups respectively while fortnightly values of body weight gain were 432± 4.00 and 472±2.00 g at 1st, 474±2.00 and 514±6.00 g at 2nd, 526±3.00 and 572±4.00 g at 3rd, 577±4.00 and 622±6.00 g at 4th, 637±4.00 and 681±4.00 g at 5th , 692±1.00 and 740±0.00g at 6th, 741±4.00 and 780±5.00 7th and 741±4.00 and 780±5.00 g at 8th fortnight. Analysis of variance results revealed significantly ($^{**}p<0.01$) higher average daily gain and fortnightly body weight gain of the calves in the treatment (T_1) group than in the control (T_0) group. The significantly ($^{**}p<0.01$) higher daily body weight gain and fortnightly body weight gain in the treatment group were due to respective higher body weight of the calves in the treatment group than in the control group resulting from the supplementation of garlic powder . The improvement in average daily gain of Sahiwal calves may be because of the antimicrobial action of organosulphur compounds of garlic. (Pourali et al., 2010)

Current results were supported by Ghosh et al. (2010), Balamurgan et al. (2014), and Lad et al. (2022) who did a similar study on crossbred calves and found significant ($^{**}p<0.01$) higher average body weight gain. Pourali et al., (2010) found that garlic supplementation promotes the performance of the intestinal flora and also improve digestion. Ahmed et al. (2009) also reported supplementation of garlic significantly increased in the average daily gain in buffalo calves as compared to control group. Dehghan et al. (2017), also observed in Holstein calves treated with 0.5% garlic powder, the highest average daily growth when compared to 1% garlic powder and the control group.

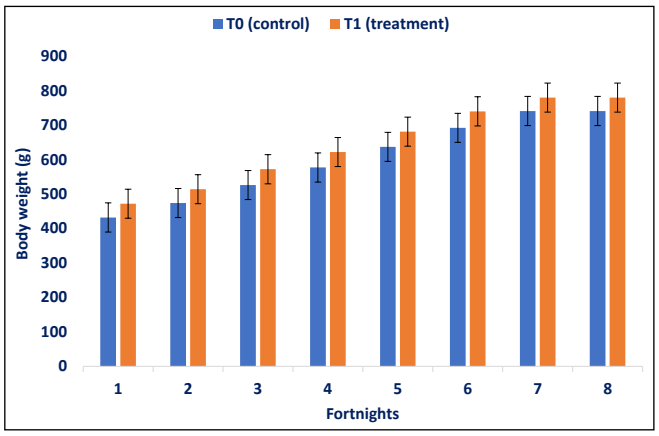

Figure 2: Graphical representation of average daily weight gain (g) of Sahiwal calves during experimental period

3.1.3. Daily dry matter intake (DMI)

The overall average DM intake was 2.98±0.06 kg and 2.97±0.07 kg in the control (T_0) and treatment group (T_1) respectively. The DM intake (kg) values of the Sahiwal calves in control (T_0) and treatment (T_1) groups at different fortnights were 2.34±0.03 and 2.33±0.03 kg at 1st, 2.47±0.03 and 2.44±0.02 kg at 2nd, 2.69±0.03 and 2.67±0.01 kg at 3rd, 2.90±0.03 and 2.92±0.02 kg at 4th, 3.06±0.03 and 2.96±0.02 kg at 5th, 3.28±0.02 and 3.22±0.01 kg at 6th , 3.45±0.02 and 3.49±0.02 kg at 7th and 3.62±0.02 and 3.70±0.03 kg at 8th fortnight respectively. Analysis of variance results revealed no significant ($^{*}p>0.05$) difference in overall or fortnightly average DM intake between control (T_0) and treatment (T_1) groups.The current finding is found similar to Balamurugan et al. (2014), who reported inclusion of garlic powder at the dose rate of 250 mg kg^{-1} body weight in the diet did not showed a significant influence on the feed intake in the crossbred calves.

3.2. Feed conversion ratio (FCR)

The average feed conversion ratio in the control (T_0) and treatment (T_1) groups was 6.10±0.07 and 5.26±0.08 in the 1st fortnight and 4.88±0.05 and 4.73±0.06 in the 8th fortnight respectively. The overall mean feed conversion ratio for the whole period was 5.42±0.06 in control (T_0) and 4.96±0.04 in treatment (T_1) groups. The average fortnightly feed conversion ratio are presented in Table 2. Analysis of variance results revealed that there was a highly significant ($^{**}p<0.01$) effect of supplementation of garlic powder on the feed conversion ratio of the experimental animals. The lower and better value of FCR in the treatment group was due to highly significant ($^{**}p<0.01$) body weight gain in that group and non-significant DM intake between the two groups. Similar to the current findings, Ghosh et al. (2010)

Table 2: Average fortnightly feed conversion ratio of Sahiwal calves during experimental period

Fortnight	Groups	
	T_0	T_1
1	6.10±0.07	5.26±0.08
2	5.71±0.05^{a}	5.18±0.05^{b}
3	5.69±0.04^{a}	5.20±0.07^{b}
4	5.52±0.04^{a}	5.10±0.02^{b}
5	5.29±0.04^{a}	4.76±0.06^{b}
6	5.15±0.04^{a}	4.73±0.03^{b}
7	4.98±0.03^{a}	4.71±0.02^{b}
8	4.88±0.05^{a}	4.73±0.06^{b}
Overall	5.42±0.06^{a}	4.96±0.04^{b}

Means with different superscripts within a row differ significantly

in crossbred calves and Hassan et al. (2015) in growing buffalo calves found an improvement in feed conversion ratio by supplementing garlic in the diet.

3.3. Conformation traits

3.3.1. Body length

The average values of initial body length (cm) at the beginning of the experiment were 54.03±4.26 and 54.09±3.35 cm and the final body length were 93.17±4.47 and 104.33±2.93 cm in control (T_0) and treatment (T_1) groups respectively. The overall values were 74.53±2.12 and 79.31±2.41 cm respectively in the control (T_0) and treatment (T_1) groups (Table 3). Analysis of the variance of results revealed a highly significant ($^{**}p$<0.01) difference between the overall values and also revealed a significant effect of treatment on the body length of the experimental calves at the 8th fortnight. This may be due to the result of a highly significant ($^{**}p$<0.01) body weight gain of the calves in treatment (T_1) group.

The result of the current study are in the agreement with past research workers Lad et al. (2022) , they reported a significant increase in body length of crossbred calves and buffalo calves respectively on supplementation of garlic in the diet.

3.3.2. Chest girth

The average initial chest girth at the beginning of the experiment was 70.37±4.32 and 70.375±3.41 cm and the final chest girth at the end of the experiment of experimental calves was 97.87±4.46 and 109.15±2.93 cm and overall mean chest girth 86.40±1.74 and 90.80±1.91 respectively for control (T_0) and treatment (T_1) groups (Table 3). Analysis of the variance of results revealed a highly significant ($^{**}p$<0.01) difference between the overall values and also revealed a significant difference of treatment on the body length of the experimental calves at the 8th fortnight. This may be due to the result of highly significant ($^{**}p$<0.01) body weight gain of the calves in the treatment (T_1) group.

The result of the current study are in the agreement with past research workers Lad et al. (2022) , they reported a significant increase in chest girth of crossbred calves and buffalo calves respectively on supplementation of garlic in the diet.

Table 3: Average fortnightly body length, chest girth and height at wither of the experimented calves

Fortnight	Body length		Chest girth		Height at wither	
	T_0	T_1	T_0	T_1	T_0	T_1
0	54.03±4.26	54.09±3.35	70.37±4.32	70.375±3.41	59.01±4.45	59.09±3.57
1	59.70±4.11	60.87±3.28	76.2±4.11	77.18±3.28	64.7±4.10	65.26±3.34
2	65.86±4.31	67.54±3.52	80.87±4.32	82.84±3.52	71.29±5.55	72.84±4.18
3	72.70±4.11	74.24±3.48	85.9±4.11	88.24±3.48	78.27±4.37	80.21±4.06
4	75.80±4.16	80.97±3.53	89.5±4.16	93.20±3.53	83.83±5.04	85.17±4.21
5	77.67±3.87	83.58±3.39	90.79±3.87	96.79±3.39	87.08±4.79	92.83±2.46
6	83.63±3.94	91.12±3.58	92.53±3.94	97.11±3.58	90.68±3.84	95.12±3.36
7	88.17±4.64	97.00±3.57	93.59±4.64	102.34±3.57	82.40±4.64	91.04±3.57
8	93.17±4.47^a	104.33±2.93^b	97.87±4.46^a	109.15±2.93^b	86.67±4.47^a	98.03±2.93^b
Overall (μ)	74.53±2.12^a	79.31±2.41^b	86.40±1.74^a	90.80±1.91^b	78.22±2.00^a	82.18±2.10^b

Means with different superscripts within a row differ significantly

3.3.3. Height at wither

The average initial height at wither measurement at the beginning of the experiment was 59.01±4.45 and 59.09±3.57 cm and the final height at wither measurement at the end of the experiment of experimental calves was 86.67±4.47 and 98.03±2.93 cm respectively for control (T_0) and treatment (T_1) groups. The overall mean values were 78.22±2.00 and 82.18±2.10 cm respectively in the control (T_0) and treatment (T_1) groups (Table 3). Analysis of variance of results showed a significant ($^{**}p$<0.01) difference between the overall values of height at wither in control (T_0) and treatment (T_1) groups at the 8th fortnight and in overall height at wither. This may be due to the result of a significantly ($^{**}p$<0.01) higher body weight gain of the calves in the treatment (T_1) group.

The result of the current study are in the agreement with past research workers Lad et al. (2022) also reported a significant increase in height at wither of crossbred calves and buffalo calves respectively on supplementation of garlic in the diet.

3.3.4. Correlation between body weight and body measurements

The coefficient of correlation value between body weight

and body length in the control and treatment groups are 0.78 and 0.89 respectively. The coefficient of correlation value between body weight and heart girth were 0.63 and 0.81 in the control group (T_0) and treatment group (T_1) respectively (Table 4). The coefficient of correlation value between body weight and height at wither were 0.60 and 0.80 in the control group (T_0) and treatment group (T_1) respectively. Statistical analysis revealed that body weight had a highly significant ($^{**}p<0.01$) positive correlation with body length, chest girth, and height at wither.

The findings of the present investigation are similar to the findings of different research workers. Prihandini et al.(2020) also reported that body measurements like body length, height at wither, and chest girth show a high correlation with body weight.

Table 4: Correlation coefficient of body weight with body measurements

Groups	Body length	Chest girth	Height at wither
T_0	0.78**	0.63**	0.60**
T_1	0.89**	0.81**	0.80**
Total	0.84**	0.73**	0.70**

**Highly significant ($p<0.01$)

3.4. Cost of feeding (rs) of Sahiwal calves during experimental period

For an economic analysis of feeding of the experimental calves, DM consumption rate, cost per kg DM intake, cost of feed incurred in the control group, cost of feed plus cost garlic in the treatment group, feed cost per calf in both the groups, body weight gain were taken into account and respective data for the economic parameters were calculated out. It has been recorded both in the control (T_0) and treatment (T_1) groups, total DM consumption per calf was 325.20 and 356.03 kg, cost of per kg feed (DM) was Rs. 15.42 and 15.42, and the cost of feed per group was Rs. 5532.87 and 5489.90 , the total cost of garlic powder Rs. 0.00 and Rs. 300 , the net cost of feed per calf was Rs. 5532.87 and Rs. 5789.90 , net cost of feeding per calf per day Rs. 46.12 and 48.25, weight gain per calf was 30.00 and 32.00 kg, and final cost of feeding per kg gain was Rs. 184.42 and 177.33 From the above results, it was observed that the total cost of feeding was a little higher in the treatment group (T_1) than in the control group (T_0). But the total body weight gain was higher in the treatment group (T_1) than in the control group (T_0) which resulted in a lower cost of feeding per kg weight gain in the treatment group (T_1) than the control group (T_0). Feed is the most expensive aspect of calf rearing.

Throughout the experiment, the treatment group had higher body weight gain and non-significant feed intake as compared to control group. The higher feed cost in the treatment group was related to the higher garlic price rate, but the feed cost per kilogram body weight growth in the treatment group was reduced due to the lower FCR in the treatment group compared to the control group.

The current study's findings are consistent with those of Ghosh et al. (2010), who found that the feed cost per calf per day in the treatment group receiving garlic supplements was 13.45% more than in the control group. The mean feed cost (Rs.) per kilogram of body weight gain was 161.61 and 231, respectively, and it differed substantially ($^{**}p<0.01$) between the treatment and control groups. In comparison to the control group, the feed cost per kilogram of body weight gain was 42.94% lower in the treatment group. Similarly, Aji et al. (2011) reported an increased feed cost per kg weight gain in birds supplemented with garlic in their diet as compared with the control group.

4. CONCLUSION

The supplementing garlic powder at a dosage of 250 mg kg^{-1} body weight were economic and could enhance growth performance of Sahiwal calves by increasing the digestibility of feed. Feed conversion ratio was found to be better in the calves supplemented with garlic. However, Garlic supplementation increased cost of feeding of calves, but, the cost of feeding per kg body weight gain was less than the control group.

5. ETHICS APPROVAL

The research was carried out according to the guidelines of Institutional Animal Ethics Committee of Assam Agricultural University, Khanapara, Guwahati-781022 as per the ethics application approval number 770/GO/Re/S/03/CPCSEA/FVSc/AAU/IAEC/21-22/925 dated 20.08.2022.

6. ACKNOWLEDGEMENT

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