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Assessment of the impact and control of aquatic leech using *endod* in selected areas of central and north Gondar zones, Northwest Ethiopia

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ABSTRACT

A Cross-sectional and follow-up study designs were done from February 2022 to July 2022 in selected districts. The aim was to assess the role of *Endod* in the control of leech and the farmer's knowledge about leech. Estimation of leech prevalence prior and post *Endod* applications were conducted. Counting was performed by five people within five minutes, a 50-meter distance apart. The knowledge was assessed using a questionnaire. The current finding revealed that 98% of the respondents were aware of the leech as the major animal health problem. The mean leech count per person per 5 minutes before the application of it ranged from 12–21.5 in different streams. A stock solution of *Endod* berries suspended in water for 16 hours was continuously applied to various streams so as to maintain a concentration of 20 g/m3 of water for 6 hours. Application of *Endod* caused mortality of most of the leech populations, with a mean reduction rate of 94.4–100% that persisted for a minimum of 30 days post application. Most of the local communities stated that *Endod* made the treated water bodies free of leech for the first 30 days. No visible livestock toxicity was noticed due to its application. In conclusion, *Endod* could be used to control leech in the study area with continuous application for 6hrs at a concentration of 20g/m3. However, care should be taken in using the appropriate concentration and it should not be used in water bodies that contain fish because it is toxic to fish at the dose required to control leeches.

Keywords: Control, *endod,* infestation, leech, north Gondar zone, central Gondar zone

1. INTRODUCTION

Livestock is an important part of the national economy and the livelihood of many communities around the world. Livestock accounts for 20-30% of the nation's GDP and for some farmers, livestock can account for up to 70% of total cash revenue (Atsbha, 2016). Ethiopia has the largest livestock population in Africa, with 65 million cattle, 40 million sheep, 51 million goats, 8 million camels

and 49 million chickens in 2020 (Central Statistics Agency, 2020). A number of diseases affect livestock and do have impacts on their production and productivity, resulting in unknown socioeconomic losses. In many parts of Ethiopia, leeches, hirudiniasis are the most neglected of these. Although it is highly prevalent in cattle, all domestic animals are susceptible to infection. The disease is treatable either using western or traditional medicine. Endod (*phytolacca dodecandra*) is used in traditional medicine and the current study aimed to evaluate its effects on the Leech parasite in water bodies.

2. METHODS AND MATERIALS

Study areas

The research was carried out in Amara Regional State, Ethiopia, in the districts of Dabat and Debark in the north Gondar zone and Wegera in the center Gondar zone. The Debark district, which has 33 administrative kebeles, is 830 kilometers from the capital Addis Ababa. It is located at latitude 13.133oN and longitude 37.900°E, between 2712 and 3122 meters above sea level. Between 900 and 1400 mm of rain fall occurs annually in the region, with both long and short wet seasons. The average minimum and highest temperatures per year are 6.2 °C and 20.7 °C, respectively, with a humidity range of 25 to 83.5%. Dabat district is located 823 kilometers from Ethiopia's capital city, Addis Ababa. There are 32 commercial kebeles on it. It is situated between 1500 and 3200 meters above sea level at latitudes of 12.9814 north and 37.7623 east. On average, the district receives between 800 and 1400 mm of rain per year. Its inhabitants are dependent on livestock. The Wegera district, which has 42 distinct kebeles, is 800 kilometers from Addis Ababa, the capital of Ethiopia with 1,539 meters above sea level. Most people rely on livestock and subsistence farming to survive. They are situated at 13° or 13° north latitude and 37.6667° or 37° 40' 0" east longitude.

Study Population

The study populations included water bodies and livestock owners. The study includes water bodies used by communities for a variety of purposes in addition to providing drinking water for their animals. In this study questionnaire survey also was done to evaluate knowledge, attitude and practices of owners.

Study Design and Period

The study was a cross-sectional one that follows an experimental design as well to see the effect of Endod and it was conducted from February 2022 to July 2022.

Sample Size determination and sampling techniques

In order to account for the possibility of leech infestation in the research locations, one kebele was purposefully chosen in each of the three districts. For each kebele, one water body was selected based on the history of leech infestation where animals and or people used it. Streams and specific sites along the streams for application of Endod were also identified by the local people. Overall, 196 respondents were included in the interview and their participation was based on willingness. The formula presented by Arsham, (2002) was used to calculate the sample size for the questionnaire survey: N = 0.25/SE2, where N = sample size, e (standard error = 3.6%). N=0.25/ (0.036)2, n=192.3 this rounded to 194. Due to fear of missing of some individuals 1% was added to it making 196 study participants.

Estimation of leech prevalence Estimation

Leech count

We used a blind counting method to determine the number of leeches in water bodies in five minutes by using different five people at a time to collect leeches within 50 meters of the stream while an animal was drinking, disturbing the water with a hand and appearing to be drunk from the water used to determine the prevalence of leeches in each stream. Then we took the average mean of the five person counts. Counting was made 4 times, counting before and after Endod was applied; the first 24 hours, followed by the next 15 days and finally the last 30 days after application.

Questionnaire survey in community and livestock owners

For this study, semi-structured questionnaires were used. The questionnaire was prepared in English and then changed into the Amharic language. Aside from socio-demographic profiles, the questionnaire included questions about leech knowledge, attitude and practice. An interview was also conducted to assess the impact of leech in the area on animal health and human health prior to intervention, as well as after application one month and three months later.

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Participatory Control Methods of Leech Infestations Using Endod on Water Bodies

Awareness creation for the community and group discussion

The purpose of the study was explained to farmers and prior to application awareness about the significance of Endod application for the control of leech was made to the community. Additional importance of Endod was also explained to them. During the discussion, although Endod plant toxicity to cattle has not yet been documented, they were instructed that animals should not drink treated water for 24 hours after Endod berry soap application. By doing these or having clear communications, collaboration and full support was obtained from the community.

Preparation and calculation of the concentration of Endod soapberry

According to the process outlined previously by the Ministry of Agriculture (MOA), powder made from Endod type 44 unripe berries (from the Ethiopian Agricultural Ceft) and/or Endod soap berries that are readily accessible locally was manufactured (2006). In brief, the volume of water flow was estimated by multiplying the mean depth, the width and length of water body areas. If water is flowing, the speed of water flow per second was estimated to determine the amount of Endod required treating the water bodies. A piece of paper was placed in the water and allowed to move 4 meters down the stream. By measuring the time needed, the speed of the water flow could be determined. All measurements were made at least four times along the water stream, with the mean result being used as the basis for calculations even though this result was done for stagnant water. Due to that volume of water, m^3=depth*width*length.

Application of prepared Endod into the water bodies

A big jar that can hold the prescribed concentration of stock solutions was placed after measuring accurately the required volume of water and amount of Endod. Then the grounded Endod berries were pre-soaked for 16 hours before being added to the water stream. Spraying was used to treat water bodies with constant water flow into and out of the ponds and small stagnant water. Spraying was done for six hours to address whole volume of water by using spraying plastic material.

Assessment of the impact of the Endod

In the two seasons, dry and rainy, the leech's pattern of distribution is distinct. It makes sense to compare the parasite load before and after using the powdered Endod soap berry solution. Therefore, the number of leeches in the study water bodies were counted and compared before, 24 hours, 15 days and 30 days after the application of the study material solution. Through a questionnaire survey and interview conducted three months following the adoption of the control measures, the impact of the control method was evaluated among the communities. Most critically, the effect of the implemented control strategy on the leech and on non-targeted aquatic lives was also evaluated. Several fresh water aquatic species were obtained both before and one day after Endod treatment.

Data management and analysis

Before analysis, data was cleaned, processed and coded using the latest version of the Statistical Package for Social Studies (SPSS). We used both descriptive and ANOVA. A chi-square test was performed to compare proportions, with a level of significance set at 0.05 and frequencies are intended to be used to calculate the prevalence of leech infestation for questioners. Mean number of leeches counted per person per five minutes was calculated by simple arithmetic mean and mean percentage reduction after application was done by subtracting mean from number of leeches after treatment from mean number leeches before treatment.

3. RESULTS

Water Bodies assessment in Dabat, Debark and Wegera

From these three districts' three water bodies, namely, Zebena River, Minich Gedib and Mariam Wuha were selected. Additionally, the communities were aware of endod and its significance. People used endod, but most of them didn't know how it would affect leeches.

Socio- Demographic Characteristics of the Respondents

For this study a total of 196 individuals were participated. The age of participants ranged from 15 to 62 years old with the mean age of 34.4 $\pm$10.0. The majority of them were over the age of 35–44 (36.1%), followed by those between the age groups of 25–34 (29.6%),

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15–24 (16. 8%), 45–54 (13.3%) and over 55 (4.1%). Of the total respondents 98 % (192/196) were aware of leech infestations to livestock. Then point two of the respondents had no formal education, while the rest were literate and came from a variety of educational backgrounds, including adult education (26.5%), primary school (35.5%), secondary school (22.4%) and preparatory (5.6%). Among the participants 29.1% lived in the study area for more than 20 years, while only 12.8% had very recently join the study place. A chi-square test showed significant association between knowledge about leech infestation and duration of survival in the study area ($p< 0.05$) (Table 1). From this finding who lived for 0-6 years in the area knew less about leech infestation than those who lived for more than 6years. Respondents were knowledgeable about the presence of leech infestation in livestock were almost the same across the three districts where it was 98.48%, 98.46% and 96.92% in Dabat, Debark and Wegera districts, respectively.

Table 1 Association of socio demography factor with knowledge of leech infestation in the study areas, 2022

Factors	Category	Respondents (%)	Having Leech infestation knowledge n (%)	X^2	P value
Age(year)	15-24	33(16,8)	29(87.88)	20.169	.0001
	25-34	58(29.6)	58(100)		
	35-44	71(36.2)	71(100)		
	45-54	26(13.3)	26(100)		
	>55	8(4.1)	8(100)		
Sex	Male	142(72.4)	141(99.3)	4.606	.032
	Femal	54(27.6)	51((94.44)		
Position in family	Male head	106(54.1)	106(100)	7.678	.022
	Femal head	48(24.5)	47(97.92)		
	Family member	42(21.4)	39(92.86)		
Education	No formal	20(10.2)	20(100)	5.736	.220
	Adult	52(26.5)	52(100)		
	Primary	69(35.5)	68(98.55)		
	Secondary	44(22.4)	42(100)		
	Prepatory	11(5.6)	10(90.91)		
District	Dabat	66(33.67)	65(98.48)	1.667	0.434
	Debark	65(33.16)	64(98.46)		
	Wegera	65(33.16)	63(96.92)		
Staying period	1-6	49(25.0)	46(93.88)	5.982	.201
	6-12	57(29.1)	56(98.25)		
	13-18	34(17.3)	34(100)		
	19-24	25(12.8)	27(100)		
	Above 24	31(15.8)	31(100)		

Livestock holder's knowledge, Attitude and practice about Leeches

The KAP of the community in the study areas was assessed and an overall KAP mean percentage of 86.2% was recorded. The findings are presented below.

Knowledge

Ninety percent of the responders noted leech and 97.4 % know its symptoms such as coughing, bleeding from the mouth, emaciation and swelling of the neck region in leech-infested animals. Nearly 96% of the respondents said that leeches had a significant negative influence on animals by impairing their ability to gain weight. According to the respondents, the main water sources for cattle in the research areas were small rivers, irrigation canals and standing water bodies. Based on their response 60.2% infestation occurs at the stagnant water bodies, followed by irrigation, 13.8% and 5.1% of river water. In fact, 19.4% respondent stated that all the three sites are infested by leech and most agreed that leeches are more prevalent during the dry season

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particularly from mid-December to June. Additionally, they said that cattle are the most susceptible species, regardless of age or sex. In general, nearly 98% of the respondents were knowledgeable about Leech (Table 2).

Table 2 knowledge of respondents about leech in the study areas, 2022

Knowledge	frequency	%
Do you leech?	192	98
Do you know that animals are infested by leech?	191	97.4
Which domestic animals' are more affected by leech infestation?	191	97.4
Which clinical sign do you observed?	191	97.45
Which season of leech occurrence highly?	191	97.45
Which water bodies which highly affected by leech?	191	97.45
Mean		97.5%

Attitude and Practices

Among the participants nearly 95% had understanding about the impact of leech, the impact of the parasite on animals feeding and weight gain and its impact on animal's product quality such as milk and meat. The current study showed a mean attitude of nearly 90%. Livestock owners used a variety of treatments, control and preventive measures to prevent, control, or treat leech infestations in domestic animals. Some of the measures taken by the respondents include manual removal of the leech; limiting drinking water to their animals; supplying water by fetching using containers (34 respondents, 17.3%); watering with salt water; watering with crushed and dissolved leaves of "Lenquata," "Swaria" and "Endod." Furthermore, 57 (29%) of respondents said that as a preventive measure, they will deny their animals direct access to leech-infested water bodies or waterlogged areas. Among 196 respondents, 79(40.3%) used Aswaria, Endod and Lancuta leaves and or seeds to treat contaminated water by applying the prepared solution at night time when animals are turned back home. However, 26 (13.3%) of the responders who knew there was a leech infestation in the water had no idea how to manage or control it. The mean practice percentage in the area was recorded as 54.2% and the practice/observation seen the impact of Endod after application was 49.7% (Table 3).

Table 3 Attitude of respondents about leech in the study areas, 2022

Attitude	Frequency	%
Understanding the impact of leech	186	94.9
Understanding impact of disease on animals feed acquire and weight gain	186	94.9
Judging the impact of leech on animals' product specially milk and meat	186	94.9
Attitude about the impact of disease on animals working time	165	84.18
Understanding the impact of treatment cost	150	80,65
Thought about Endod wider use	179	91.3
Recommendation of respondents about Endod is important	179	91.3
Mean		89.54
Practice		
Asuraia ,Endod,L Ancata	79	40.3
keep away animal from affected area	57	29.1
Fetching of water for animals drink	34	17.3
Control mechanism of leech by respondent	168	85.71

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Do you think that application of Endod on the water bodies reduce the impact of leech on animals?	177	98.33
Average of Practice percentage		54.2
What was significant change on health aspects after water treated by Endod?	176	97.78
What was significant change on animal production aspects after water treated by Endod?	176	97.78
What was significant change on working time and cost of treatment to animals after water treated by Endod?	156	79,6
Is there any animal affected by leech after treated water by Endod on treated water?	6	3.1
Average experience/practice percentage of after intervention		49.7%

Leech infected water body's treatment using endod

For this study 7.2kg, 8.4Kg and 10.0Kg Endod was used in Mariam Wuha, Zebena River and Minch Gedib, respectively (Table 4). Leech counting was done pretest and posttest, and then took mean of five-person blind count. The leech found in the area and the mean of leech counted put in the figure and table below (Fig 1, Table 5).

Table 4 The volume of water and amount of endod (20gram/1meter cubic) used in the study area, 2022

District	Water body	Mean depth(m)	Mean width (m)	Mean length(m)	volume of water flow(m3)	Required Amount of Endod in (kg)
Dabat	Mariam wuha	0.8	3	150	360	7.2
Debark	Zebena river	1.5	4	70	420	8.4
Wegera	Minch gedib	0.7	3	250	525	10.0

Figure 1 The leech and counting

Table 5 The efficacy of endod on leech in different streams in the study areas, 2022

Study area			Mean leech count/ person / 5 minutes(%reduction)			
District	Kebele	Stream	24 hour before application	24 hour post application	Day 15 post application	Day 30 post application
Dabat	Woken	Mariam wuha	18.4	0(100)	0.8(95.7%)	1(94.56%)
Debark	Zebena	Zebena river	12	0(100)	0.4(96.7%)	0.8(93.3%)
Wegera	Hiskdebir	Minch gedib	20.8	0(100)	1(95.2%)	1.4(93.3%)

One way ANOVA analysis showed a significant difference at P-value <0.05 in the three districts, where the F-ratio recorded as 64.81, 66.74 and 70.42 in Dabat, Debark and Wegera districts, respectively (Table 6).

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Table 6 ANOVA result of Leech mean count in the study sites, 2022

Dabat (Weken)					
Source	SS	Df	MS	F-ratio	P-Value
Between-treatments	1190.95	3	393.0	*F = 64.81*	P< .00001
Within-treatments	98	16	6.1		
Total	1288.95	19			
Debark (Zebena)					
Between-treatments	500.55	3	167.0	*F = 66.74*	P< .00001
Within-treatments	40	16	2.50		
Total	540.55	19			
Wegera					
Between-treatments	1505.2	3	502.0	*F = 70.42*	P< .00001
Within-treatments	114	16	7.13		
Total	1619.2	19			

SS: Sum Square; DF: Degree of Freedom; MS: Mean Square

Other aquatic fauna, including tadpoles, adult frogs, small fish and various round worms, were affected by the application of Endod. Mortality of tadpoles was evident a few hours after application and at 24 hours post application. A number of dead tadpoles were noticed along the streams and small fish were also found dead. However, 30 days post application of Endod there were a large number of tadpoles and small fish in each treated water body.

Evidence of effectiveness of Endod on leech parasite after three months

Out of 180 participants who could recall using Endod as a remedy to control leech at the research sites, 177 (98.3%) farmers said that it was successful in eliminating leech parasites in water bodies, whereas the other three respondents disagreed. Additionally, Endod treated water had no adverse effects on animals 24 hours after treatment. One hundred seventy-six (89.8%) said that the water was free from and they believed that animal health and product quality could improve. 156 (86.67) said that treatment costs were reduced and animal power had improved. Above all, the livestock owner had a desire to use Endod beyond the use of it as a leech control agent. In the pretest and posttest observations, there is a mean reduction of leech (almost 100%). This finding was strengthened by the farmers as well. Three months post-application, the community was again interviewed on the level of reduction in the problem of leech due to its application and all of them agreed that Endod application dramatically decreased the leech population in the streams and animal infestation was rarely encountered. Seventy-five percent of respondents said they did not see their animals infested by leech for 30 days after applying it and 16.5% said its application protected their animals for up to two months, while the remaining 9% said Endod application protected their animals for three months.

4. DISCUSSION

According to the findings of the interview, leech is a serious livestock and human health problem in the districts of Dabat, Debark, and Wegera. Leech infestation is reported to be high during the dry season due to rapid drop in water volume, which causes water stagnation and slow flow of water, creating a favorable environment for leech multiplication throughout the dry season. According to the local communities, the size of streams has dramatically reduced to a low level in the early dry season, especially from the beginning of November to the end of April.

According to respondent knowledge, Leech was reported to be the major (97.5%) constraint to water utilization by livestock in the dry seasons. This finding was in agreement with Duguma and his colleagues where they reported 97.5% (Duguma et al., 2011). Ninety-seven percent of the participants were knowledgeable and aware about leech infestation in livestock and this was similar to the reports from Ethiopia and Tanzania (Nyamsingwa, 2016; Amsalu et al., 2019). According to respondents, leech infestation was season-dependent and was endemic mostly during the hot and dry season, when there was a decrease in the number of water pools that are accessible for cattle to drink and the finding was in line with (Nyamsingwa, 2016). They also stated that aquatic leeches had significant economic importance in the area and that they highly affected animals by resulting in cough and weight loss. This finding was in agreement with (Lemma, 1983).

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In this study, factors such as sex, position in the family and age were significantly associated (p =0.05) with the respondents' knowledge about leech infestation. In this regard, males (99.3%) were more knowledgeable than females (94.4%) (2=4.606; p =0.05). Similarly, male heads (100%) knew more about leech infestations than their counter parts (97%) and family members (92.86) (2 = 7.678; p 0.05). In this survey, it was also noticed that respondents aged > 25 years were knowledgeable (100%) compared to age groups of 15–25 years (2=20.169; p= 0.001). It is true that under normal conditions, as a person's age increases (becomes older or older), it is expected that knowledge also increases, since age is positively correlated to knowledge and this could be the possible explanation for the above finding.

The utilization of Endod (*Phytolacca dodecandra*) at a concentration of 20g/m3 maintained for 6 hours in water has been shown to give a significant reduction in the prevalence of the parasites in water bodies and this result was in line with previous results reported by (Mulilo et al., 2020). According to the respondents and personal observations after 24 hours, there were no visible observed side effects in animals that had been drunk, implying that Endod may have a lower toxicity effect on animals (Lemma, 1983). Based on this, Endod applied to leech-infested watering sites within the recommended dose and application method has no effect on an animal's health or productivity at any age or physiological status (Legesse et al., 2006).

Application of Endod on the streams at a concentration of 20 g/m3 of water for 6 hours has shown a significant reduction in the number of leeches in the water bodies in the study areas. Complete eradication of leeches was achieved within 24 hours of post application, which persisted for 30 days in most of the streams. The reduction percentage ranged from 93.3 to 100%. This finding was in agreement with the previous laboratory evaluation of Endod on leech (Lemma, 1983; Mulilo et al., 2020; Legesse et al., 2006; Eguale et al., 2010); because leeches are susceptible to Endod, the current study findings suggest that it could be used for leech prevention and control in the study areas.

Other aquatic fauna, including tadpoles, adult frogs, small fish and various round worms, were affected by the application of Endod. Mortality of tadpoles was evident a few hours after application and 24 hours post application. A number of dead tadpoles were noticed along the streams and small fish were also found dead. However, 30 days post application of the material; there were a large number of tadpoles and small fish in each treated water body. This indicates that Endod did not kill the eggs and hatched, which resulted in an increase in their number in 30 days and this agrees with Eguale and his colleagues (Eguale et al., 2010).

Three months post application of the test material, the community was interviewed on the level of reduction of leech due to its application, and all of them agreed that Endod application dramatically decreased the leech population in the streams that led to animal infestation, which was rarely encountered. Seventy-five percent of respondents agreed that they did not see their animals infested by leech for 30 days after applying Endod, with 16.5% reporting that their animals were protected for two months and the remaining 9% reporting that the material protected their animals for three months.

The current report regarding one- and three-month protection was lower than the report made by Eguale *et al*., (2010) where they reported 25% said for one month protection and 50% claimed for three months protection. This variation could be due to the differences in the application of Endod to the water body. This may also prevent animals from drinking from such types of water bodies.

5. CONCLUSION AND RECOMMENDATIONS

The current study's findings reveal that leech infestation is common and has an impact on animal health and production. Local communities in the study areas are well aware of leech infestations in water bodies. The current study suggests the presence of leeches in certain observed water bodies, as well as a higher prevalence of leech infestation in livestock. Leech infestation was found to be more common in cattle and during the dry season. Farmers and local communities drench and apply medicinal plants to cure and control leech infestations in both bodies of water. The current study suggests that Endod significantly reduces leech infestation in water bodies with a minimum or without observable side effect on aquatic fungal growth. As a result, the following recommendations are made based on the conclusion. Giving special attention to the neglected leech infestation problem, working on other traditional medicines and finding ovicidal medicaments are suggested.

Ethical approval

Not applicable.

Informed consent

Not applicable.

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Conflicts of interests

The authors declare that there are no conflicts of interests.

Data and materials availability

All data associated with this study are present in the paper.

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