



# Procine Cysticercosis: A Neglected Zoonoses and Its Economic Impact in North East India

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### ABSTRACT

Post mortem screening for porcine cysticercosis cyst were carried out in different markets and pig slaughter house of Assam, Meghalaya, Arunachal Pradesh, Mizoram and Tripura. From January 2015 to February 2018, a total of 4856 carcasses has been examined for cyst. Based on post mortem examination the overall period prevalence was found to be 0.97%. Economic losses due to condemnation of affected meat were calculated as of ₹ 191890.00 (\$ 2734.84). Cysts were found highest in shoulder muscle followed by heart muscle, thigh muscle, neck muscle, masseter muscle and tongue. Our results indicate that porcine cysticercosis is prevalent in North East India and accounts for high economic losses due to condemnation of edible organs/meat.

## 1. Introduction

Cysticercosis in animals is caused by the larval stages (metacestodes) of cestodes of the family Taeniidae (tapeworms), the adult stages of which occur in the intestine of humans, dogs or wild Canidae (OIE, 2014). *Taenia saginata* of humans causes bovine cysticercosis whereas *Taenia solium* of humans causes porcine cysticercosis and human neurocysticercosis (NCC). The immature stages (metacestode or cysticerci) of the parasite enter into the animal body through contaminated fodder, silage or hay in the form of gravid proglottids and/or eggs followed by hatching in intestine and subsequently via blood circulation enter into vital organs and musculature (Bhadri *et al.*, 2014). Man acquires infection from adult worms, as a result of eating raw or undercooked pork infected with the larval form of *T. solium* ('measly pork'), the condition is known as taeniosis (Tsang and Wilson, 1995). Porcine cysticercosis has impact on economic loss due to the decrease in meat sales and from the increased condemnation of meat and edible organs.

Identification of infected pigs with viable larvae is achieved through detection of the secreted products of viable parasites, whereas exposures, in the absence of viable parasites, are often associated with detectable levels of circulating antibody. Therefore, inspection of carcasses for presence of cyst as well as serological test for detection of specific antibodies is useful tool for diagnosis of the disease. The presence of porcine cysticercosis in an area indicates the presence of active transmission of the parasite between pigs and humans and pigs are normally targeted in order to control the problem (Sciutto *et al.*, 1998).

Almost 90% of the inhabitant of North East India are non-vegetarian and consumed pork as the main source of animal protein since it was much cheaper than other meat. However, there are limited studies from this region of India reporting the prevalence of porcine cysticercosis and its economic impact. Thus this study aimed at estimating the prevalence of cysticercosis lesions in the pork meat and associated direct economic losses due to condemnation of organs/tissues of slaughtered pig.

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## 2. Materials and Methods

### 2.1 Study Area

The study was carried out between January 2015 to February 2018 in different markets and pig slaughter house of Assam, Meghalaya, Arunachal Pradesh, Mizoram and Tripura (Figure 1). More than 10000 animals were slaughtered annually in these unorganised markets and slaughter houses which served more than 15 million consumers.

### 2.2 Sample Collection

The total number of carcasses for the study was calculated based on the formula given by Thrusfield (2007).

$$N = \frac{Z^2 P(1 - P)}{D^2}$$

Where N is the required sample size, Z is the z-score at different confidence interval, P is the expected prevalence and D is the desired absolute precision.

A 5% expected prevalence with 99% confidence interval and 1% desired absolute precision was used to determine the sample size required for the study. Hence, substituting these values the required sample size was determined to be 3152 carcasses. But to increase the precision of our estimates, the total numbers of animals included in the present study were 4856. The sample units were selected using simple random sampling method from those animals brought for slaughter on the market day.

### 2.3 Post mortem inspection and prevalence estimation

All animal carcasses were inspected by qualified, well-trained veterinarians. Tongue inspection was performed before slaughter and pig was considered positive for cysticercosis if cyst-like nodules were either seen or felt (Gonzalez *et al.*, 1990). Immediately following slaughter the presence of cysticerci in the carcass was assessed by examining *T. solium* cysticerci predilection sites, including the masseter muscles, triceps brachii muscle, tongue and liver (Figure 2). The muscle groups excised from the half carcasses together with the complete heart, tongue, head and neck muscles, psoas muscles, diaphragm, lungs, kidneys, liver, brains and eyes. Cysts that were encountered on incisional and intact surfaces were classified and enumerated as either viable or degenerated (Boa *et al.*, 2002).

Prevalence was estimated as per Elmonir *et al.* (2015):

$$\frac{\text{Total number of infected carcasses}}{\text{Total number of slaughtered animals}} \times 100$$

### 2.4 Economic losses estimation

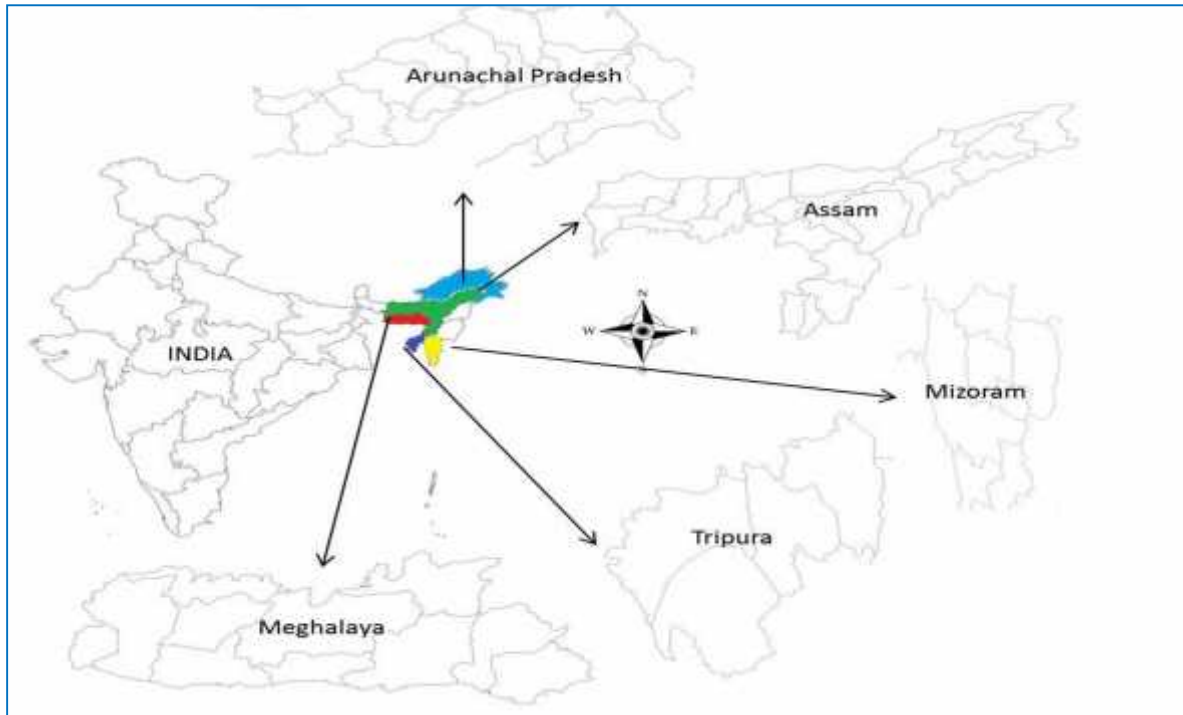
Direct Economic losses due to condemnation of muscle or organs with cyst were estimated based on total weight loss of meat in Kilogram (Kg) and average market price per kg as per the following formula used by Munde (1999).

$$\text{Total Economic loss} = \text{Total weight of carcasses condemned} \times \text{Price per kg of meat}$$

During the study period, butchers and slaughterhouse personnel were interviewed for data of the average weight and market price for edible (muscles, lungs, heart, liver, kidney and spleen) and non-edible (intestine, uterus) organs/tissues of pig carcasses. The average meat yield for the whole carcass of pig was 70 kg (65-75 kg). The average price for 1 kg of meat was ₹ 240.00. The average weight for shoulder muscles, Neck muscle and Thigh muscle was 12kg, 3kg and 7 kg respectively. The price of brain (Including masseter muscle and tongue) was ₹ 100.00 per kg and that of heart was ₹ 50.00. Indirect annual economic loss (IAEL) was estimated based on annual average slaughter in the abattoirs of these regions (AAS), average price of 1Kg condemned meat/organ (AP) and prevalence rate (P), *i.e.* IAEL = AAS x AP x P.

## 3. Results and Discussion

In this study, the overall prevalence of porcine cyst among 4856 pig carcasses examined in different markets and slaughter house of Assam, Meghalaya, Arunachal Pradesh, Mizoram and Tripura during the period from January 2015 to February 2018 was 47 (0.97%). Yearly prevalence rate was recorded as 1.18 %, 0.92 % and 0.91 % during 2015-16, 2016-17 and 2017-18 respectively (Table 1). These decreasing trends of prevalence rate from 2016 to 2018 in our study might be due 'Swatchh Bharat Abhiyan' (Clean India Mission) campaign run by Government of India, under which one objective is eliminating open defecation through the construction of household-owned/community-owned toilets and real time monitoring of good hygiene and sanitary practices. Similar to our findings the low prevalence of porcine cysticercosis was also reported by Nath (2018) as 1.09% in Assam. Biswakarma (2017) also reported 1.83% of porcine cysticercosis in three district of Arunachal Pradesh (West Kameng, East kameng and Papum-Pare) and adjoining border areas in Sonitpur and Lakhimpur district of Assam. Out of 47 positive carcasses, it was found that shoulder muscle contributed highest cyst lesions with a percentage of 0.89% followed by heart muscle (0.68%), thigh muscle (0.62 %), neck muscle (0.60 %), masseter muscle (0.57 %) and tongue (0.32 %) (Figure 2). Findings from our study is in agreement with Shinde (1991), Munde (1999) and



**Figure 1.** Map of India showing Assam, Meghalaya, Arunachal Pradesh, Mizoram and Tripura, the five states of North East India. (Map not to scale).

**Table 1.** Year wise distribution of screening of pig carcasses for cyst and economic loss due to condemnation of various organs.

Study period	Organs	Total carcasses screened	Animal suspected (Prevalence)	Cyst lesions	Total weight (Kg)	Total Loss (₹)
2015-2016	Shoulder muscle	926	11 (1.18%)	10	120	28800
	Neck muscle			6	18	4320
	Thigh muscle			12	84	20160
	Heart muscle			9	2.25	112.50
	Massetor muscle			11	5.50	550
	Tongue			3	0.60	60
Total (2015-16)				51	230.35	54002.50
2016-2017	Shoulder muscle	2275	21 (0.92%)	19	228	54720
	Neck muscle			12	36	8640
	Thigh muscle			9	63	15120
	Heart muscle			16	4	200
	Massetor muscle			6	3	300
	Tongue			6	1.20	120
Total (2016-2017)				68	335.20	79100
2017-2018	Shoulder muscle	1655	15 (0.91%)	13	156	37440
	Neck muscle			10	30	7200
	Thigh muscle			8	56	13440
	Heart muscle			7	1.75	87.50
	Massetor muscle			10	5	500
	Tongue			6	1.20	120
Total (2017-2018)				54	249.95	58787.50
Overall (2015-2018)		4856	47 (0.97)	173	815.50	191890

Bhadrige *et al.* (2014) who reported 100%, 92% and 91.30% prevalence in shoulder muscle, respectively. Similar to our finding Bhadrige *et al.* (2014) also found 65.21% of cyst lesion in slaughtered pig in Deonar abattoir, Mumbai, however a lower prevalence was reported by Pramanik *et al.* (1985) and Shinde (1991). In the present study, the prevalence of cyst lesion in thigh muscle was found to be 0.62%, which is also in accordance with Shinde (1991) and Bhadrige *et al.* (2014) who reported 60% and 56.52% prevalence in thigh muscles respectively. Therefore, inspection of shoulder muscle is the best possible method for detection of porcine cysticercosis at market level.



A.



B.



C.



D.

**Figure 2.** Cyst lesions in pig carcass A) Shoulder muscle B) Tongue C) Neck muscle D) Thigh muscle

meat production at Deonar abattoir, Mumbai. Based on oral interview with the butchers, it was estimated that annually an average of 10000 animals were slaughtered in these abattoirs. Indirect economic loss was calculated considering prevalence rate of 0.97% and average price of ₹ 240.00 per Kg condemned meat/organ. Indirect annual economic loss (IAEL) was found to be ₹ 23280.00 (\$ 33178.94) due to condemnation of meat.

## Conclusion

From the current study, it can be concluded that porcine cysticercosis is prevalent in North East India and also results in loss of revenue to pig rearers. Keeping in mind the zoonotic transmission of cysticercosis, awareness of public, regular meat inspection and good hygiene practices are recommended. Therefore more studies should be carried out to further improve the knowledge based practices and transmission of porcine cysticercosis in endemic areas. PM examination measures and awareness programme regarding knowledge of occupational zoonoses and risks factors might be helpful to diminish the incidence of porcine cysticercosis.

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The overall weight losses of organs in Kg from all the slaughtered carcasses were 815.50 (Table 1). A total of ₹ 191890.00 (\$ 2734.84) was lost due to condemnation of organs affected with cyst lesion. However lower loss of money due to cysticercosis was reported by Bhadrige *et al.* (2014) in northern part of the India. Who reported that a total of ₹39705 due to *C. cellulosae* to the pig

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