



## Prevalence of *Cysticercus cellulosae* infections in pigs in parts of Arunachal Pradesh and Assam

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### ABSTRACT

The state Arunachal Pradesh and Assam of India are situated in north eastern region of India, inhabited by local tribes of different caste, community and religions with different food habits and customs where pork is one of the preferred animal proteins. The different systems of pork cuisine and social customs of pig rearing and human – pig correlation makes the area vulnerable for meat borne tapeworm diseases. Three prime districts of state Arunachal Pradesh *i.e.* West Kameng, East Kameng and Papum-pare and two adjoining bordering districts of the State Assam *i.e.* Sonitpur and Lakhimpur were selected to study the prevalence of mealy pork infections in pigs for one calendar year effecting from March 2016 to February, 2017. For this a total of 654 pig carcasses were examined in 17 market places in both the states that revealed overall prevalence of *C. cellulosae* as 1.83% with a distribution of 2.00% and 1.78% and in Assam and Arunachal Pradesh, respectively. Age-wise, overall prevalence was highest in the age group of 12-18 (2.50%) with no infection in the age group of 1-6 month. Breed wise, the overall rate of prevalence was higher among the cross bred pigs (1.99%) than the indigenous breed (1.65%). Sexwise, overall prevalence was little higher in female pigs (1.85%) than male pigs (1.82%). Season wise, overall prevalence rate was highest during winter season. Month wise highest prevalence was detected in the month of November (4.65%). Besides, site of predilection and density of cysts of *C. cellulosae* were also discussed. It can be concluded from the present study that *C. cellulosae* infections is prevalent in pigs of two north eastern states of India which may be considered as a lower percentage of infections but it warranting human sanitation and hygiene in pig-man cycle of the infections.

### 1. Introduction

Porcine *cysticercosis* is a disease caused by larval stage of *Taenia solium* known as *Cysticercus cellulosae*. Pigs are infected through consumption of human faeces or through drinking water and feed contaminated with *T. solium* eggs. *T. solium* taeniasis in man is the only source economic losses in pig industry. *Cysticercosis* is common in communities where pigs are allowed roam freely, consumed raw pork and lack of basic sanitary practices (Prasad *et al.*,

2007). Since time immemorial the relationship of man and pig in terms of taeniasis/cysticercosis is understood and man is primarily responsible for transmission to pig whereas pig act as transmitter secondarily because pig is ignorant and speechless, bears no knowledge of harboring the organism.

Now time has come for absolute human awareness on the diseases of all classes rather than blaming the pig species. Arunachal Pradesh ‘the land of the down-lit mountains’ situated in the eastern most part of India is the largest state in

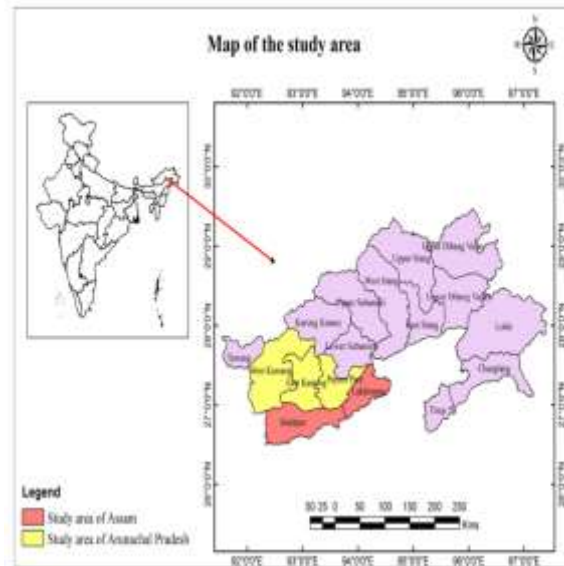
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terms of area in the entire North-East, is situated in 260 28' to 290 30' N latitudes and 91030' to 970 30' E longitude. The state is hilly terrainous in geo-physiography. The total pig population in the state is 3.47 lakh (2012 Quinquennial Census report). Arunachal Pradesh is situated in a strategic location and bounded in the 3 frontiers by foreign countries (China in the north and east, Myanmar in the east and Bhutan in the West). The state has bordering area of adjacent state Assam, the people from Arunachal Pradesh frequently visits these areas as main traders/ consumers of pork. Because of the porous nature of its boundaries, it is very crucial from zoonosis point of view. Not much systematic work has been carried out in these areas of these two states to understand the status of zoonotic parasitic diseases and the disease entity in these states is questionable and needs attention. Moreover, owing to typical mongoloid socio cultural life style, it is imperative to know the status of pig related cysticercoid diseases. Although few reports of *C. cellulosae* infections in some districts of Assam are available but no study undertaken regarding the prevalence of *C. cellulosae* infections in Arunachal Pradesh. Keeping in view of the above, the present study was undertaken to study the prevalence of porcine cysticercosis in three districts of state Arunachal Pradesh and adjoining bordering areas of two districts of Assam.

## 2. Materials and Methods

### Study Area

Three districts of Arunachal Pradesh (*viz.* West Kameng, East Kameng and Papum-Pare) and two closely adjoining areas of Assam to these districts of Arunachal Pradesh, namely Sonitpur and Lakhimpur districts of Assam (Figure 1) where the consumer from Arunachal Pradesh frequently visits to these pork markets were selected for the study of prevalence of *Cysticercus cellulosae* infections. The study was carried out in total 10 nos. of organized markets (haats) in selected districts of Arunachal Pradesh. The organized markets (haats) under West kameng district were situated in Rupa, Bomdila and Bhalukpong; under East Kameng district was in Seijosa and under Papum-Pare district were in Itanagar, Naharlagun, Doimukh, Nirjuli, Banderdewa and Balijan. In Assam the study was conducted in 7 nos. of haats and these are Charduar, Lokhra, Khelmati, Itakhola, Balijuri and Borgangunder Sonitpur district and Harmoti under Lakhimpur districts of Assam. Efforts were also made to visit and examined pigs sacrificed during festival, celebrations and social occasions apart from the organized haats and markets.



**Figure 1.** Map showing the study area of Arunachal Pradesh and Assam

### Examination of Carcass

Alternate weekly visits to these markets were made in different localities of these selected areas and haats. Pig carcasses brought for human consumption were examined as per method of Thornton and Gracey, 1974 for presence *C. cellulosae* and details of age, sex and breed of carcasses were recorded. The carcasses were viewed from opening of the cadavers till separation of offals and making marketable piece block of pork. All the visceral organs like tongue, lung, liver, heart, spleen and body muscles were thoroughly examined for presence of larval cestodes. Materials collected as such were transported in icebox to the working laboratory of the Department of Parasitology, College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati – 781022. During the period of study, a total of 654 nos. of slaughtered pig carcasses of both states were examined for presence of *C. cellulosae* and out of these 504 nos. of carcasses were from Arunachal Pradesh and 150 nos. of carcasses were from Assam.

### Season wise prevalence

To study the seasonwise prevalence the whole one-year period of observation was divided into four seasons as per India Meteorological Department (IMD), LGBI, Guwahati airport. These were (a) Pre-monsoon season (March, April, May), (b) Monsoon season (June, July, August) (c) Post-Monsoon season (September, October, November) and (d) Winter season (December, January, February).

### Density of cysts in pig carcass

The positive tissue pieces that were brought to the laboratory in ice-box (Igloo box) were examined thoroughly for total number of *C. cellulosae* cysts present in them.

An amount of 50 grams of tissues each from affected sites (skeletal muscles, liver, diaphragm, heart) of each affected carcasses irrespective of their nativity were taken for the study of distribution of cysts and calculated in terms of numbers of cysts per 50 gms of tissue.



**Figure 2.** *C. cellulosae* in skeletal muscles

### 3. Results and Discussions

#### 3.1 Prevalence of *Cysticercus cellulosae* infection

A total of 504 numbers of pig carcasses were examined in ten different markets in Arunachal Pradesh and out of these nine pigs (1.78 %) were found positive for *C. cellulosae* infection. A total of 150 numbers of pig carcasses were examined in seven nos. of different markets of Assam which reveal three (2.00%) positive cases. Thus overall infection rate of *C. cellulosae* on examination of 654 carcasses in both the states with specified districts were 1.83% (Table 1) (Figure 2). Separately, the prevalence rate of *C. cellulosae* in three districts of Arunachal Pradesh were found to be 1.53%, 2.4% and 1.71% in West Kameng district, East Kameng district and Papum-Pare district, respectively (Table 2). Similarly, the prevalence rate of *C. cellulosae* in two districts of Assam was found to be 1.56 % and 4.5% in Sonitpur district and Lakhimpur district, respectively (Table 3).

#### Agewise prevalence

The different age groups maintained throughout the investigations were 1-6 months, 6-12 months, 12-18 months and above 18 months and the overall prevalence recorded in these two states were 0, 2.10, 2.50 and 2.70 percent, respectively (Table 4). Overall the age-wise prevalence of *C. cellulosae* in pigs of three districts of Arunachal Pradesh revealed 0, 1.76, 2.98 and 2.94 percent in 1-6 months, 6-12 months, 12-18 months and above 18 months, respectively. Similarly, overall age-wise prevalence of *C. cellulosae* in pigs of two districts of Assam revealed 0, 3.38, 1.51 and 0 percent in 1-6 months, 6-12 months, 12-18 months and above 18 months, respectively.

#### Breedwise prevalence

Overall a total of 303 nos. of indigenous pigs and 351 nos. of cross bred pigs were examined, the prevalence was 1.65% and 1.99%, respectively. The infection seems to be little higher among crossbred pigs (Table 5). Statewise in Arunachal Pradesh, the prevalence was 1.66% and 1.89% among indigenous pigs and cross bred pigs respectively. District wise, the prevalence rate in West Kameng district, East Kameng district and Papum-Pare district in indigenous and cross breed pigs were 1.33% and 1.80%, 1.88% and 3.33%, and 1.78% and 1.67%, respectively. In Assam, the prevalence among indigenous pigs and cross bred pigs were 1.58% and 2.29%, respectively. Districtwise, the prevalence rate in indigenous and cross breed pigs in Sonitpur district. was 1.78% and 1.38% and in Lakhimpur district was 0.00 and 6.66%, respectively.

#### Sexwise prevalence

A total of 384 nos. of male pigs and 270 nos. of female pigs were examined, the prevalence was 1.82% and 1.85%, respectively (Table 6). In this study, female animals were found to be more infected than the male. Statewise in Arunachal Pradesh, sex-wise prevalence in male and female was 1.68% and 1.93%, respectively and in Assam, 2.29% and 1.85% infections were observed in male and female pigs, respectively.

#### Seasonal prevalence

Overall season wise prevalence of *C. cellulosae* infections in pigs of both Arunachal Pradesh and Assam revealed 0.78%, 0.00%, 2.15% and 2.59% during pre- monsoon, monsoon, post monsoon and winter seasons, respectively. Statewise seasonal prevalence rate of *C. cellulosae* in pigs of Arunachal Pradesh shows 1.05%, 0.00%, 2.09% and 2.33% during pre-monsoon monsoon, post monsoon and winter seasons, respectively indicated during the winter season the prevalence rate was highest. State wise seasonal prevalence rate in Assam found to be 2.32% and 3.57% during post monsoon and winter season, respectively but no infection was recorded during pre-monsoon and monsoon. The infection rate of *C. cellulosae* was higher during winter in Assam as well.

#### Monthly prevalence

Overall monthly prevalence of *C. cellulosae* in pigs of Arunachal Pradesh and Assam revealed positive cases in the month of March (1.69%), November (4.65%), December (2.97 %) and January (3.66%). In other months no positive cases were recorded. Highest prevalence was detected in the month of November (4.65%). Separately, in Arunachal Pradesh, highest prevalence was recorded in the month of November 3 (4.54%) followed by the month of January 3 (3.48%), December 2 (2.56%) and March 1 (2.27%). In Assam, positive cases were found in the month of November 1 (4.76%),

December 1 (4.34%) and January 1 (4.54%). Prevalence rate was highest in the month of November.

### **Prevalence in Organs/ Muscles**

Out of total 12 nos. of infected pigs, the distribution of *C. cellulosae* were 100% in brachiocephalic muscle, 100% in Latuisimusdorsi muscle, 100% in Biceps muscle, 75.0% in intercostal muscles, 50.0% in diaphragm, 41.66% in liver and 8.33% in heart. Highest distribution was found in skeletal muscles. No infection was found in tongue. It was observed that accumulation of *C. cellulosae* in skeletal muscles was more concentrated viz. Brachiocephalus, Latuisimusdorsi and Biceps muscle (100%) whereas in liver and diaphragm the distribution was 44.4% each and in intercostal muscles, 77.7 percent, in Arunachal Pradesh. The study in Assam shows, the incidence of *C. cellulosae* in different organs/locations as highest (100%) in Brachiocephalus, Latuisimusdorsi and Biceps muscle followed by 66.6 percent in Diaphragm, intercostal muscles and 33.3 percent in liver and heart.

### **Density of *C. cellulosae***

In 50 gram of tissue each from liver, heart, diaphragm and skeletal muscles of pig carcasses contained *C. Cellulosae* cysts that ranged from 5.00 -15.00, 8.00 – 16.00, 15.00 – 40.00 and 20.00 – 50.00 numbers respectively (Figure 6). The corresponding mean  $\pm$ SE of cysts were  $10.00 \pm 1.68$ ,  $12.00 \pm 1.20$ ,  $27.50 \pm 5.20$ ,  $35.50 \pm 5.50$  respectively. Highest number of cysts (20.00 – 50.00) per 50 gram of tissue sample was found in skeletal muscles and lowest (5.00 – 15.00) was found in liver. In spite of global endemicity and mass involvement of people, bladder worm diseases remain as neglected zoonosis in pig in many developing countries. The diseases are always under reported due to absence of clinical symptoms in affected pig, poor functioning of meat inspection services and lack of established surveillance systems specially in endemic countries. Indian urban and rural populations are at risk of these zoonotic infections because of their intimate association with animals, lack of awareness on etiology, sources and preventive measures of most of the zoonotic infections. (Jyothimol and Ravindran, 2015). The present study is the first report of its kind regarding systematic investigation on porcine cysticercosis in West Kameng, East Kameng, Papum-Pare districts of Arunachal Pradesh and bordering areas in Sonitpur and Lakhimpur districts of Assam. The present study revealed overall 1.83 percent prevalence of porcine cysticercosis in the study areas with a distribution of 1.78% in Arunachal Pradesh and 2.00 % in Assam. Deka *et al.*, 1985 recorded that prevalence of porcine cysticercosis as 20.80% in Assam. Besides that, from Assam and Meghalaya, 11.90% and 1.22% infections in pigs reported earlier (Plain, 1991).

In a subsequent study made by Barkataki *et al.*, 2012 the disease from Nagaon, Morigaon and Karbi Anglong district of Assam was recorded 7.55, 8.20 and 13.70 percent, respectively. In more recent study in Sivasagar district of Assam made by Kakoty *et al.*, 2017 recorded 1.72 percent infections. Porcine cysticercosis being a country wide problem has also been reported from Uttar Pradesh (Deka and Gaur 1990; Prasad *et al.*, 2002), Punjab (Sharma *et al.*, 2005), Jammu (Sharma *et al.*, 2017) and Kerala (Hafeez *et al.*, 2004). Overall prevalence in these two states as per age although revealed highest in the age group of more than eighteen (2.70%) which is non-significant difference from the prevalence of the age group of 12-18 months (2.50%) and no infection was noticed in the age group of 1-6 months. Previously, Deka and Gaur, 1990 and Sarti *et al.*, 1992 reported that the prevalence of cysticercosis increases with increase of age. However, many workers (Pramanik *et al.*, 1985; Pathak and Gaur 1989; Onah and Chiejina, 1995) did not find any significant effect of age on the occurrence of *C. cellulosae*. It was evident that the young piglets were taken care of properly by tethering, hence did not have opportunity to acquire infections, although Saravanan *et al.*, 2014 reported the highest prevalence in the age group of 1-12 month from Bareilly, UP. The prevalence of *C. cellulosae* was found to be more in cross-bred pigs than in indigenous breed. Pramanik *et al.*, 1985 recorded higher prevalence of *C. cellulosae* infection in cross-bred than in indigenous pig.

Similarly, Barkataki *et al.*, 2012 recorded higher infection in cross-bred (12.5%) than in indigenous breed (7.49%) pigs. Saravanan *et al.*, 2014 reported that the prevalence of porcine cysticercosis more in cross bred animals (5.88%) than nondescript local breeds (4.10%). The present finding was in agreement with those of above workers. However, it differs with that of Pathak and Gaur, 1989 who had recorded highest prevalence rate among indigenous pig (8.90%). This finding might be due to the fact that cross-bred pigs are generally more susceptible and less resistant to the infection compared to the indigenous (local) pigs. Sex-wise prevalence revealed overall little higher in female than male but separately in Assam it was more in male than female. Previously, Plain, 1991 recorded higher prevalence of *C. cellulosae* in females (12.50%) than male (11.11%). Similarly, Barkataki, 2012 and Biu and Ijudai, 2012 recorded higher infection of *C. cellulosae* 10.39% and 5.1% percent in females and 9.15 and 2.70 percent males, respectively. A marginally higher prevalence of porcine cysticercosis in females also observed by Saravanan *et al.*, 2014. The present finding was in agreement with the findings of above workers. However, slight higher prevalence in males than females was recorded by Sarti *et al.*, 1992 and Sharma *et al.*, 2004 to which the findings of present study in Sonitpur and Lakhimpur district in Assam was in conformity. It is common feature that males are generally slaughtered in early age as

found in above, than the females kept for breeding purposes has enough time to pick the infection while scavenging. The overall seasonal prevalence of porcine cysticercosis in the present study was found to be highest during the winter season 2.33% in Arunachal Pradesh as well as in Assam (3.57%), which was in contradiction with the findings of Deka, 1989, who recorded lowest infections in winter but was in agreement with the findings of Barkataky *et al.*, 2012 who also found low prevalence of porcine cysticercosis during monsoon season. The monthly prevalence in the present study was found to be highest in the month of November. It was interesting to note that there was fluctuation of infection in the study areas with no infection was recorded during the rainy season from April to October whereas the infections were primarily recorded during dry sunny autumn and winter seasons from November to March during which most of the pigs are let loose for scavenging and more numbers of pigs are slaughtered that may lead to increased endemicity for human taeniasis during the period.

In the present study, distribution of *C. cellulosae* were recorded highest in skeletal muscles. This is in conformity with those of Deka *et al.*, 1985 and Plain, 1991 who recorded more incidence of *C. cellulosae* in skeletal muscles. In the present study, density of the cysts per 50 gram of tissue each from heart, liver and skeletal muscles of 12 infected pig carcasses were recorded. The highest mean  $\pm$  SE of cyst was found in skeletal muscles ( $35.50 \pm 5.50$ ) and lowest in heart ( $10 \pm 1.68$ ).

From this region, Kakoty and Islam, 2014 recorded highest density of cysts in skeletal muscles ( $25.25 \pm 5.25$ ). Earlier Plain, 1991 made a similar study and found highest density of the cysts in skeletal muscles. This might be attributed to ecology of the parasite, particularly in skeletal muscles they get more surface area to proliferate compared to other organs.

**Table 1.** Overall prevalence of *C. cellulosae* infections in pigs of states Arunachal Pradesh and Assam

State	No. of Districts covered	No. of Markets visited	No. of carcasses exam.	No. of carcasses positive	Prevalence (%)
Arunachal Pradesh	3	10	504	9	1.78
Assam	2	7	150	3	2.00
Total	5	17	654	12	1.83

**Table 2.** Prevalence of *C. cellulosae* infections in pigs in three districts of state Arunachal Pradesh

District	Markets visited	Number of carcass examined	Number of positive cases	Prevalence (%)
West Kameng	Bhalukpong	80	2	2.5
	Rupa	24	0	0.00
	Bomdila	26	0	0.00
East Kameng	Seijosa	83	2	2.4
Papum-Pare	Balijan	23	0	0.00
	Doimukh	40	1	2.5
	Banderdewa	68	2	2.9
	Naharlagun	55	0	0.00
	Itanagar	30	0	0.00
	Nirjuli	75	2	2.6
Overall		504	9	1.78

**Table 3.** Prevalence of *C. cellulosae* infections in pigs in two districts of the state Assam

District	Revenue circle markets	Markets visited	Number of carcass examined	Number of positive cases	Prevalence (%)
Sonitpur	Charduar	Khelmati	24	1	4.16
		Charduar	15	0	0.00
		Lokhra	34	1	2.9
	Sotea	Itakhola	30	0	0.00
		Balijuri	12	0	0.00
	Borgang	Borgang	13	0	0.00
Lakhimpur	Naoboicha	Harmoti	22	1	4.5
Total			150	3	2.00

**Table 4.** Overall age-wise prevalence of *C. cellulosae* infections in pigs of the states Arunachal Pradesh and Assam

Age group (Months)	Number of carcass examined	Number of positive carcass	Prevalence (%)
1-6	132	0	0.00
6-12	285	6	2.10
12-18	200	5	2.50
> 18	37	1	2.70
Total	654	12	1.83

**Table 5.** Overall breed -wise prevalence of *C. cellulosae* infections in pigs of the states Arunachal Pradesh and Assam

Breeds	Nos. of carcasses examined	Numbers of Positive cases	Prevalence (%)
Indigenous breed	303	5	1.65
Cross breed	351	7	1.99
Total	654	12	1.83

#### 4. Conclusions

It can be concluded from the present study that the infection rate of *C. cellulosae* encountered is of low profile in pigs in study areas of both the states which bears an encouraging message for fellow countryman on human health and sanitation as far as pork consumption is concerned.

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**Table 6.** Overall sex -wise prevalence of *C. cellulosae* infections in pigs of the states Arunachal Pradesh and Assam

Sex	Nos. of carcasses examined	Numbers of Positive cases	Prevalence (%)
Male	384	7	1.82
Female	270	5	1.85
Total	654	12	1.83

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