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# Pesticide residue induced blemished water bodies in the riparian tributaries of Chalakkudy River

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**Abstract**
Agricultural, industrial, and techno-socio-cultural intervention by man had an influence on the quality of the river water and its tributaries. Contemporary agriculture practices reveal and augment the use of pesticides to meet the food security and to satisfy the needs of surging population which results in contamination of the aquatic environment. In the pursuit to achieve maximum crop production, pesticide use has played a major role and has resulted in the accumulation of pesticide residues deemed to be highly detrimental to aquatic and related ecosystem. This study funded by Kerala State Council for Science, Technology and Environment was aimed at understanding the extent of pesticidal residues and pollution of water bodies in the riparian tributaries of Chalakkudy river. The efforts to assess the quality of water in the Chalakkudy tributaries confirmed the presence of pesticide residues of quinalphos and ethion (0.21-2.90 $\mu gL^{-1}$) through chemical analysis in 41.18% of total number of water samples. Pesticide residues of ethion constituted 71.42% of the water sample inveterate for pesticide residues. When pesticide residues of quinalphos (4.80 $\mu gL^{-1}$) and ethion (1.80 $\mu gL^{-1}$) were detected in the middle reaches of Chalakkudy river, in the upper reaches it was ethion that was detected at maximum level (2.20 $\mu gL^{-1}$) near to Kerala Sholayar dam. Results suggest that the continuous presence of pesticide residues of ethion and quinalphos can contaminate other nearby surface water bodies or even ground water that can masquerade critical health threats to the health of local residents of this area.

**Keywords:** Ethion, quinalphos, water quality, pollution, riparian, river basin

## Introduction
Natural water bodies are reservoirs of life. Chalakkudy river, the fifth largest river in Kerala is 130 km long. Nelliampathy hills of Palakkad district in Kerala is the origin point of northern tributaries of this river. The south-eastern tributaries originate from the Anamalai Hills of Coimbatore district in Tamil Nadu. Peringalkuttu and Athirapalli are the main water falls in the river. The river takes a circuitous course of 35 km after Kanjirappally through the fertile tracts. The riverbanks are speckled with homesteads and cultivated plots. The river ultimately conjoins into the right arm of the Periyar at Elanthikkara in Puthervelika village of Ernakulam district. At least 104 fish species have been located from this river in various studies [1]. Chalakkudy River is unique in its rich fish diversity and becomes an appropriate undeclared haven of diverse fish types. The National Bureau of Fish Genetic Resources based in Lucknow (NBFGR) has recommended the upstream areas of the river to be declared as Fish Sanctuary. With deforestation in the upstream area over years at a fast pace, coupled with the intricacies of developmental activities through booming urbanisation and industrialisation [2] cum technology interventions in agriculture have added to the degradation of water bodies and demur in water quality. This decline in the quality of water can limit the accessibility of water for human use and the associated aquatic flora and fauna [3], thus becoming factors causative to water scarcity. The Problems arising out of water quality deterioration are as severe as those related to water availability making the same non potable as in the cases of various stretches of many rivers [4]. This study was conducted to assess the water quality with main focus on the existence of Pesticide Residues in the leading tributaries cum water sources in close associations of Chalakkudy River in the dry season of 2016.

## Methodology
Altogether 17 surface water samples were collected from the main-river and major tributaries during March- April 2016. PRA (Participatory Rural Appraisal) technique were employed for understanding the land use and the sites of sample collections were determined after thorough transect of the area that lasted for more than two weeks. The coordinates were fixed for sample collection. Thereafter samples collected were grouped into three categories, namely, upstream,

midstream and low stream reaches. Samples were drawn from land use categories covering forest, plantation, homestead settlement (rural, peri-urban and urban) with multi-tiered tree crops and livestock component mixed combinations. Water samples were analysed for pesticide residual limits in the 'All India Network Project on Pesticide' Laboratory of College of Agriculture, Vellayani, and Thiruvananthapuram.

**Results and Discussions**

The discussion here will be limited to pesticide residual limits, if any, on the impact of different types of land use on water quality. The results of the pesticide residual limits as identified at the time of water sample collection and analysis using the Test Method- PRRAL/MOA-01 is presented in table 1 and is summarised in table 2.

Table 1 revealed that maximum pesticide residue was found in Muzhikkakadavu Parayanthodu Confluence (Latitude 10.274376 and Longitude 76.303579 degrees), wherein residues of quinalphos (4.80 $\mu gL^{-1}$) and ethion (1.80 $\mu gL^{-1}$) was detected in the middle reaches of Chalakkudy river. However, in the upper reaches it was ethion that was detected at maximum level (2.20 $\mu gL^{-1}$) near to Kerala Sholayar dam (Latitude 10.301203 and Longitude 76.780072) which gives an interpretation that variegated agricultural practices are put in use for which the farmers rely on different types of chemical pesticides for crop care. The efforts to assess the quality of water in the Chalakkudy tributaries confirmed the presence of pesticide residues of quinalphos and ethion in 47.37% of total number of water samples collected during the survey. Ethion constituted 77.78% of the water sample inveterate for pesticide residues.

Perusal of table 2 confirms the presence of pesticide residues in the riparian tributaries of Chalakkudy river. 71.42 per cent of water samples from the upper reaches of the river convived the presence of more pesticide residues (0.70-2.90 $\mu gL^{-1}$) as against the middle to lower reaches of the river wherein only 20 per cent of the sample was detected for the presence of pesticide residues (0.21-1.10 $\mu gL^{-1}$).

The efforts made to assess the water quality in terms of extent of occurrence of pesticides in the Chalakkudy tributaries confirmed the presence of residues (0.21-2.90 $\mu gL^{-1}$) of quinalphos and ethion in 41.18% of total number of water samples collected during the survey. Out of this, residues of ethion in the range (0.21-2.90 $\mu gL^{-1}$) were detected in all the water samples and quinalphos was detected in 28.58% of samples with pesticide residues (1.62-4.80 $\mu gL^{-1}$).

The water samples were collected from the main river and major tributaries of Chalakudy river during March- April 2016. For adult males of mealy bugs (sucking pests), the estimated optimum and maximum temperature thresholds were 28.7 and 31.9 degrees C; and for adult females, they were 28.4 and 32.1 degrees C, respectively. Considering the warmer climate affinity, survey conducted in two summer seasons of 2014 and 2015 had revealed 24 coccoidean species from different floral diversity of Thrissur district and they belonged to Monophlebidae and Pseudococidae family[4]. Quinalphos is a broad spectrum insecticide recommended by Kerala Agricultural University against mealybug and scales (sucking pests) in nutmeg, coconut and arecanut @ 0.05% (2ml per litre of water) and @0.025% (1ml per litre of water) for the management of hard scale in nutmeg. The increase in population of sucking pests especially coccoidean species during the dry months of March and April 2016, resulted in an enhanced use of broad spectrum insecticides like quinalphos and the consequent residue level in water.

**Table 1:** Pesticide residual limits of surface water (analysis done on July 2016) of upper reaches and middle to lower reaches of riparian tributaries of Chalakkudy river.

| Latitude | Longitude | Residues | Results ($\mu gL^{-1}$) | LOQ ($\mu gL^{-1}$) | Land Marks |
|---|---|---|---|---|---|
| 10.323052 | 76.950461 | Ethion | 0.70 | 0.1 | Valpari town |
| 10.460018 | 76.650290 | BLQ | - | 0.1 | Karappara, Nelliyambathi |
| 10.293068 | 76.470781 | BLQ | - | 0.1 | Vettilappara Plantation |
| 10.290332 | 76.666270 | Ethion | 1.20 | 0.1 | Poringalkuthu |
| 10.301203 | 76.780072 | Ethion | 2.20 | 0.1 | Kerala Sholayar dam |
| 10.302580 | 76.593126 | Ethion | 1.10 | 0.1 | Vazhachal |
| 10.282885 | 76.926852 | Quinalphos Ethion | 1.62 2.90 | 0.1 | Nudis,Valparai |
| 10.256053 | 76.323189 | BLQ | - | 0.1 | NGL Outlet, Kathiukkudam |
| 10.274376 | 76.303579 | Quinalphos Ethion | 4.80 1.10 | 0.1 | Muzhikkakadavu Parayanthodu Confluence |
| 10.287049 | 76.345950 | BLQ | - | 0.1 | Murigoorthodu Confluence, |
| 10.303687 | 76.334725 | Ethion | 0.21 | 0.1 | Near GMBHSS Ground Chalakkudi |
| 10.304048 | 76.366614 | BLQ | - | 0.1 | Muzhikkakadavu,Pariyaram |
| 10.308858 | 76.326704 | BLQ | - | 0.1 | Stream near VR Puram road |
| 10.312140 | 76.350369 | BLQ | - | 0.1 | Koodappuzha, Arattukadavu |
| 10.322165 | 76.377252 | BLQ | - | 0.1 | Above Kappathodupalam |
| 10.211234 | 76.301893 | BLQ | - | 0.1 | Meladoorthodu /shaji |
| 10.162824 | 76.264988 | BLQ | - | 0.1 | IlanthikkaraKadavu |

BLQ - Below Limit of Quantitation & LOQ - Limit of Quantification

**Table 2:** Pesticide residual limits of surface water (analysis done on July 2016) of upper reaches and middle to lower reaches of riparian tributaries of Chalakkudy river

| Reaches (Location) | Measures | Summary | | |
|---|---|---|---|---|
| | | Presence of pesticide residues | Ethion | Quinalphos |
| Upper N=7 | Frequency and percentage | 5/7 (71.42% samples) | 5/7 (71.42% samples) | 1/7 (14.29% samples) |
| | Range of pesticide residue | (0.70-2.90) | (0.70-2.90) | (1.62) |
| Middle to lower N=10 | Frequency and percentage | 2/10 (20% samples) | 2/10 (20% samples) | 1/10 (10% samples) |
| | Range of pesticide residue | (0.21-1.10) | (0.21-1.10) | (4.80) |
| Total N=17 | Frequency and percentage | 7/17 (41.18% samples) | 7/17 (41.18% samples) | 2/17 (11.77% samples) |
| | Range of pesticide residue | (0.21-2.90) | (0.21-2.90) | (1.62-4.80) |

Chi Square

| | Ethion | Quinolphos | *Marginal Row Totals* |
|---|---|---|---|
| Upper | 71 (67.26) [0.21] | 14 (17.74) [0.79] | 85 |
| Mid to low | 20 (23.74) [0.59] | 10 (6.26) [2.23] | 30 |
| Marginal Column Totals | 91 | 24 | 115 (Grand Total) |

The chi-square statistic is 3.8181. The *p*-value is .050703. No*t* significant at $p < .01$.
The chi-square statistic with Yates correction is 2.8652. The *p*-value is .090513. *Not* significant at $p < .01$.

**Social Implications**

Agricultural activities turn out to be the mainstay occupation that contributes to the livelihood security of the local people, whether it is in the upper, mid or lower reaches of the stream. Pesticides frolicked major role in achieving the maximum crop production, but its unscrupulous usage leading to accumulation of pesticide residues becomes detrimental to aquatic and other related ecosystem. Since majority of the people depend on this river for livelihood, besides drinking water purpose, its pollution with unscientific and indiscriminate use of pesticides like quinalphos and ethion has contaminated water that can pose severe health threats to local residents of this area. This upholds the statement put forth by millennium ecosystem assessment [6, 7], that if any ecosystem has been polluted to its maximum threshold, it is the aquatic ecosystem mainly the freshwater ecosystem. Access to quality, clean and safe water for human consumption has been mandated by United Nations as 'human right' in the year 2010 [7]. It is in this perspective, the presence of pesticide residues especially in the upper reaches needs to be viewed seriously so that measures can be initiated for ensuring the quality of water not at all being affected.

The river water contamination by pesticide residues from runoffs have greater impact on the aquatic ecosystem. This may lead to ruinous effects on the aquatic organisms and human dependents on the water supply from the river [9]. Effective use of pesticides and maintenance of water quality offers a greater challenge to the essential triangulates of research, extension and clientele systems which is the need of the hour. Nutmeg, oilpalm, coconut, arecanut are some among the base dominant crops in the upper reaches of this riparian homegarden ecosystem. From the results obtained through the entire course of the study, it can be concluded that the river flowing through the plantations is continuously contaminated with pesticide runoff from the nearby fields located in the region. This affects the quality of the water flowing in the rivers and the non - target organisms like fishes thereof. Chalakkudy river in the upper reaches is the richest in terms of fish diversity. Puthenvelikkara Panchayath alone has more than 1149 inland fishermen. Various types of inland fishing activities are in this area. Since, fishing from the river and flood plain is found to be an important livelihood activity of the local people, the study confirming the pesticide residues is a matter of concern and it will have a bearing on the life of people associated with this type of riparian ecosystem. Also, children may be exposed to pesticide residues from swimming in the water, as this is a region that facilitates wide segment of heterogenous population owing to the region's importance of tourism. However, minute in its concentration, pesticides detected due to their extensive use in the past have shown prospective to bio-magnify or accrue in animal tissues, human blood, adipose tissue and even in breast milk [10]. Thus it become the most dangerous environmental contaminants because of their stability, mobility and long-term effects on living organisms [11].

**Closing Thoughts**

In these circumstances, techno-socio-economic control systems and improvement of the work environment are necessary in cultivation areas and surrounding communities. The advocacy for a total ban of these chemicals is not the solution but educating the 'masses of intervention' for its use in the right- quantity, time and space becomes assumingly important. More of purposive integration of Phyto remedial crops like pandanus for riparian ecosystem should be incorporated in the riverbanks and tributary corridors as it may help in detoxification. Government and nongovernment organizations need to establish linkages of different development departments and promote programmes on educating farmers about effective and eco-friendly pest management strategies.

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