



## Detection of many Health Hazardous Chemicals Used in Tomato Marketing in Bangladesh

Shoaib Mahmud Shaon<sup>1</sup>, Pomeuz Zaman<sup>1</sup>, S. M. Neaz Mahmud<sup>2</sup>,  
Parsha Shanzana<sup>3</sup>, Rabiul Islam Rajib<sup>1</sup>, Tawhidur Rahman<sup>1</sup>, Md. Amirul Islam<sup>1</sup>,  
Md. Rana Sardar<sup>4</sup>, Md. Shariful Islam<sup>2</sup>, Md. Humayun Kabir<sup>5</sup>, Selina Akhter Lira<sup>5</sup>  
and Shahin Mahmud<sup>2\*</sup>

<sup>1</sup>Department of Biochemistry and Molecular Biology, Jahangirnagar University, Savar, Dhaka-1342, Bangladesh.

<sup>2</sup>Department of Biotechnology and Genetic Engineering, Mawlana Bhashani Science and Technology University, Santosh, Tangail-1902, Bangladesh.

<sup>3</sup>Department of Molecular Biology and Genetic Engineering, Sylhet Agricultural University, Sylhet -3100, Bangladesh.

<sup>4</sup>Department of Pharmacy, Dhaka International University, Dhaka-1213, Bangladesh.

<sup>5</sup>Department of Environmental Science and Resource Management, Mawlana Bhashani Science and Technology University, Santosh, Tangail-1902, Bangladesh.

### Authors' contributions

This work was carried out in collaboration between all authors. Authors SM and SMS designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors SMNM and PZ managed the analyses of the study. Author PS managed the literature searches. All authors read and approved the final manuscript.

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### ABSTRACT

For the developing countries like Bangladesh vegetable like tomato is very important for the supplement of nutrient. But in many markets of Bangladesh, moderate amount of tomatoes are contaminated with the health hazardous chemicals like CaC<sub>2</sub>, formalin, ethylene, dithane, shampoo and other chemicals. In this comparative study we collected tomato samples from four major

\*Corresponding author: E-mail: [shahin018mbstu@gmail.com](mailto:shahin018mbstu@gmail.com);

divisions (Dhaka, Chittagong, Sylhet and Rajshahi) of Bangladesh and tried to measure the amounts of tomatoes that were contaminated. This survey based study revealed that huge amounts (69%) of tomatoes were contaminated with calcium carbide ( $\text{CaC}_2$ ) and more than 10% of tomatoes were adulterated with Formalin in Dhaka divisions. Tomatoes of other division's markets were more or less contaminated with different types of health hazardous chemicals. These chemicals are very toxic and injurious to health. So the use of these chemicals should be strictly prohibited to minimize the risk.

**Keywords:**  $\text{CaC}_2$ ; dithane; ethephon; ethylene; formalin; organoleptic.

## 1. INTRODUCTION

Bangladesh is mainly agriculture based country [1]. It has absolute potential for agriculture-led growth, with fertile soil, abundant water, strong research and extension institutions, and expanding infrastructure [2]. Tomato (*Lycopersicon esculentum*) is the wonderful vegetables that mainly grow in the winter seasons in the Bangladesh. For the gift of the Biotechnology and Genetic Engineering, now tomatoes are growing in the Bangladesh all around the years. Although it is produced all around the year, it is highly available at low cost during the winter. Tomato (*Lycopersicon esculentum*) is well-produced and most popular vegetables in all over the Bangladesh. At present, tomato is grown worldwide with the exception of colder regions [3]. Tomato is the third largest vegetable crop after potato and sweet potato in terms of production in Bangladesh [4]. It has rich nutritional value. Tomato is an essential component of human diet for the supply of vitamins, minerals and certain hormone precursors, in addition to protein and energy [5]. It contains vitamin A, B, and C, calcium, iron etc. Vitamin C content is 31 mg per 100 g of tomato. Now-a-days 6.10% (BBS, 2005) area is under tomato cultivation both in winter and summer [6]. As Bangladeshi land is very fertile, tomato grows well in every district of the Bangladesh, highly in the Norshindi and Rangpur districts. For low cost, high nutritional value and availability, this vegetable is eaten both in curry and as a salad.

Many early ripening agents are used in Bangladesh. Artificial ripening agents are health hazardous [7] and directly affect the ripening quality of tomato [8].  $\text{CaC}_2$  is a fast ripening agents. Its uses on the vegetables ripening are very bad and highly hazardous. Many surveys indicated that, about 70-80% of Bangladeshi local sellers used  $\text{CaC}_2$  as an early ripening agent before marketing of different fruits and vegetables. Although  $\text{CaC}_2$  is an early ripening agent but this chemical directly affects fruits

quality and reduced all the considered parameters regarding nutritional value of fruits and vegetables in a worst level.  $\text{CaC}_2$  is highly used for tomato ripening that alters the physiochemical and organoleptic properties of the tomato [9] and yield [10].  $\text{CaC}_2$  is highly toxic and has organoleptic effects [11]. It alters the colors of tomato [12] but improves the market quality [13]. Artificial chemical ripening agent is very harmful for health and eating artificial ripened vegetables is also hazardous [14]. It significantly reduces the product value, eating quality and produces the health hazardous toxicity [15].  $\text{CaC}_2$  causes memory loss, cerebral edema [16], colimic prostate and lung cancers, quick buck syndrome [17], DNA, RNA and hematological change [18]. It also produces highly toxic calcium cyanamide [19], affects nervous system (CNS/PNS) [20], reduces  $\text{O}_2$  supply in the brain, causes long term and short term health problem [21]. It is also responsible for abnormal baby from pregnant mother, peptic ulcer [22], bad headache, dizziness, mood disturbance, sleepiness, mental confusion at a short term basis [23]. This chemical decreases HB, RBC, WBC, PVC, some blood indices, alters protein. MCV, MCH and MCHC are raised due to  $\text{CaC}_2$ . Consumption of  $\text{CaC}_2$  causes heart disease, skin disease, lung failure, kidney failure, stomach upsets, frequent thirst, irritation in mouth and nose, weakness, vomiting during handling and pulmonary edema [14,24-27] weakness, skin ulcer and heart related other diseases [28-31].

Formaldehyde is the simplest member of aldehyde family but a very reactive chemical. Its gaseous form is known as formaldehyde and the liquid form as formalin [32]. Some studies suggested that huge quantity of formaldehyde exposures, for example from drinking formaldehyde solutions, are potentially lethal [33]. Formaldehyde is converted to formic acid in the body, leading to a rise in blood acidity, slow breathing, hypothermia, and coma or death. In the body, formaldehyde can cause proteins to irreversibly bind to DNA. Formaldehyde is listed

as a probable human carcinogen. Ingestion of formalin as little as 30 mL (1 oz.) has been reported to cause death in an adult human being. Ingestion may cause corrosive injury to the gastrointestinal mucosa, with nausea, vomiting, pain, bleeding, and perforation. Corrosive injuries are usually most pronounced in the pharyngeal mucosa, epiglottis and oesophagus. Systemic effects include metabolic acidosis, CNS depression and coma, respiratory distress, renal failure with associated cancer and tumor development [33]. Use of formalin in food has been banned in Bangladesh; however, formalin contamination was reported in many studies in this country [34].

International Agency for Research on Cancer (IARC) has classified formaldehyde as a Group 1 carcinogenic to humans (2004). According to the US Environmental Protection Agency (EPA), maximum daily dose reference (RfD) for formaldehyde is 0.2 µg/g body weight per day [5, 9, 32,35]. In 1985, Italian Ministry of Health has proposed formaldehyde values of sixty µg/g and ten µg/g for *Gadidae* (family of marine fish) and crustaceans (arthropods), respectively [36]. Even those who spray or inject formalin over a long period of time will likely suffer health complications such as blindness, asthma and even lung cancer [37].

Ethylene is a plant hormone [38] responsible for fruits ripening [39] that regulates by many factors [40] and used to ripe banana, tomato, apple, pineapple, melon etc. Ethylene can cause a wide range of effects in plants, depending on the age of the plant and how sensitive the plant is to ethylene. Ethylene effects include fruit ripening, loss of chlorophyll, abortion of plant parts, stem shortening, abscission of plant parts, and epinasty (bending of stems). Ethylene can be either good or bad, depending on its application. For example it is used in a positive manner in fruit ripening. But it can also be harmful. Sometimes it acts as anti ripening agent and excessive level of artificially sprayed ethylene cause neurological disorders, eye, skin and lung problems, prolonged hypoxia etc. [41]. Ethylene gas is used commercially to ripe tomatoes, bananas, pears, and few other fruits in postharvest period. Ethylene can be explosive if it reaches high concentrations. Several commercial liquid products release as ethylene (such as- ethephon, trade name ethrel). These are only used in pre-harvest period. Hakim et al. [27] have collected pineapple and banana samples from different Bangladeshi local markets

and compared to the naturally ripened and lab treated (using ethephone) pineapples and bananas. They found that chemically ripened pineapples and bananas have higher sugar content than non-treated samples; other fruit nutrition values like vitamin C and b-carotene are higher in naturally ripened fruits.

## 2. MATERIALS AND METHODS

### 2.1 Experimental Location and Time

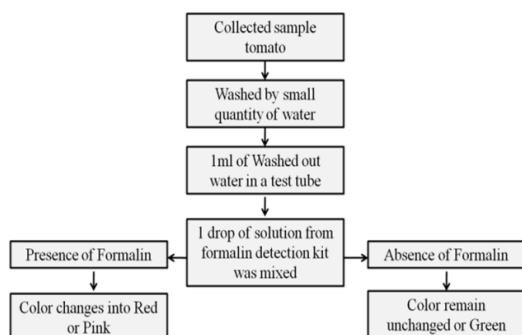
This study was conducted by collecting samples from four big division of Bangladesh namely Dhaka, Chittagong, Sylhet and Rajshahi. From the Dhaka division samples were collected from six different districts namely Dhaka, Manikganj, Tangail, Mymensing, Sherpur and Jamalpur. From the Chittagong division samples were taken from six different districts namely Chittagong, Feni, Noakhali, Rangamati, Bandarban and Khagrachori. From the Shylhet division samples were collected from Sylhet, Shunamgonj, Moulavibazar and Hobigonj districts. Further samples were collected from six different districts of Rajshahi division. 20 markets from each district were randomly selected. From each market, 10 samples were collected from 10 random whole seller / traders. 10 wholesale dealers were visited for each market and observed their pre-processing and processing their tomatoes before marketing. So, total 200 pieces tomatoes samples were collected from each district. All samples were collected from October-2015 to March-2016.

### 2.2 Detection of the Formalin

#### 2.2.1 Qualitative detection of the formalin

At first, the samples were washed with small quantity of water. Three drops of washed-out water was taken in a test-tube using a dropper. Formalin detection kit for food samples, developed by the scientist of Bangladesh Rice Research Institute (BARI) was used in this experiment. The kit contains only one solution. 1 ml of tomatoes washed water was taken in test tube. Then one drops of solution of the formalin detection kit was added in the water at the test tube. It was mixed properly by stirring. After solution was added into it, if the color of the solution changes into pink or red or colorless, the presence of formalin will be ensured. On the other hand, if the color of the solution remains unchanged or green, it indicates that there is no presence of formalin in the sample. A Flow chart

of detecting the presence of formalin was shown in Fig. 1.



**Fig. 1. Flow chart of detecting the presence of formalin**

### 2.3 Detection of Other Chemicals

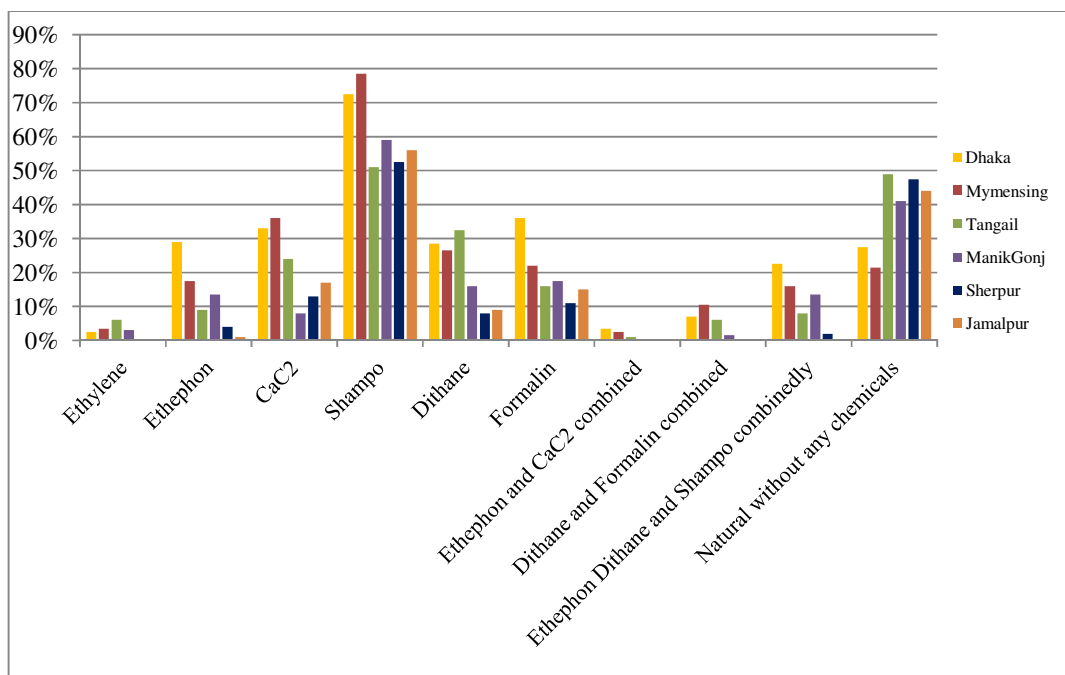
Besides formalin, other hazardous chemicals such as ethylene, ethephon, CaC<sub>2</sub>, shampoo, dithane etc. were detected by questioning the farmer and trader. Whole sellers of tomato of all markets and some farmers were visited during processing the tomatoes with health hazardous chemicals before marketing. The name of these health hazardous chemicals and purposes of using these chemicals were evaluated by questioning them. According to their answer the final result was evaluated.

### 3. RESULTS AND DISCUSSION

Most of the tomatoes in Dhaka, Mymensingh and Tangail district were contaminated with CaC<sub>2</sub>, formalin and dithane. 36% tomatoes of Tangail were contaminated with CaC<sub>2</sub> where-as in Dhaka it was 33% and 24% in Mymensingh (Table 1). Formalin detected in 36% of tomatoes of Dhaka. Dithane were found in 32.5% of tomatoes in Tangail (Fig. 2).

Like Dhaka division, in Chittagong division (Table 3) most of tomatoes were adulterated with CaC<sub>2</sub>, formalin, dithane and ethephon. Tomatoes of Noakhali were 33% contaminated with ethephon and 31.5% with dithane. Tomatoes of Feni district were contaminated with 21.5% CaC<sub>2</sub> and 23% of formalin. Ethephon content was highest in Noakhali district of Chittagong division (about 33%). (Fig. 3)

In the division of Sylhet most of the tomatoes were falsified with Dithane and Formalin. 121 tomatoes (30%) were adulterated with Dithane in Hobigonj and almost 24% in Sunamgonj and Moulvibazar. Almost 30% of tomatoes of Sylhet and Moulvibajar district of Sylhet division were contaminated with Formalin. 92 (23%) tomatoes of Sylhet were contaminated with Ethephon. In other districts content of hazardous chemicals were below 20% (Fig. 4).



**Fig. 2. Presence of hazardous chemicals in ripe tomatoes in Dhaka division**

**Table 1. Presence of health hazardous chemicals in ripe tomato samples at six districts of Dhaka division**

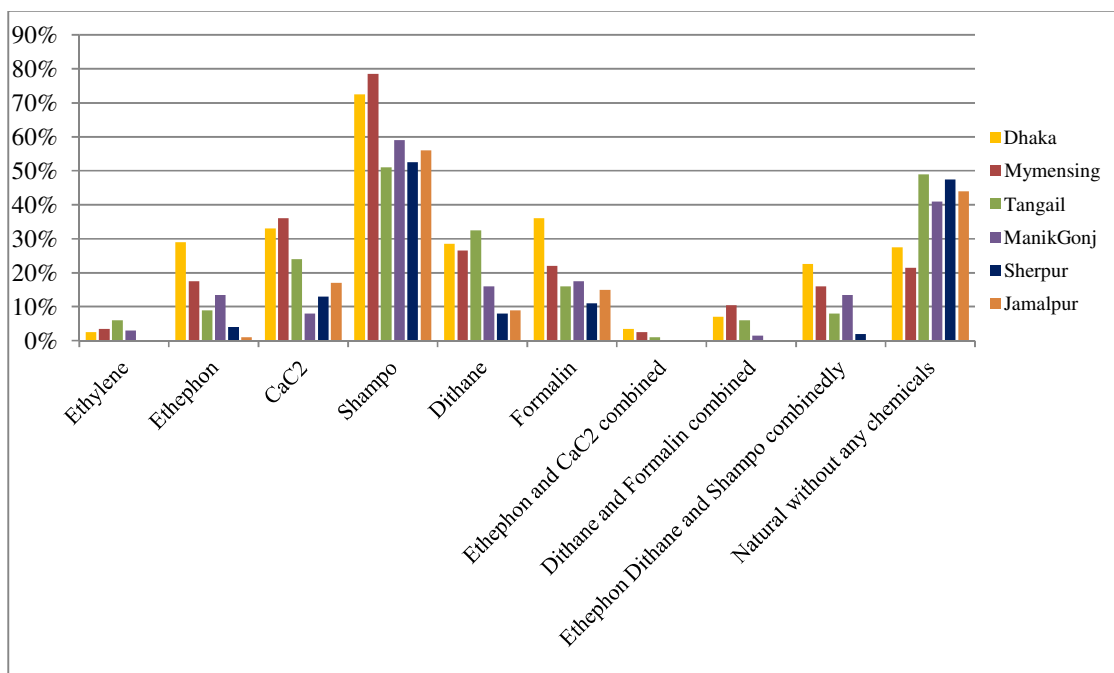
Name	Dhaka	Mymensing	Tangail	Manik-Gonj	Sherpur	Jamalpur	Total /mean data
Total samples	200	200	200	200	200	200	1200
Ethylene	5 (2.5%)	7 (3.5%)	12 (6%)	6 (3%)	Nil (0%)	Nil (0%)	120.5
Ethephon	58 (29%)	35 (17.5%)	18 (9%)	27 (13.5%)	8 (4%)	2 (1%)	24.6
CaC <sub>2</sub>	66 (33%)	72 (36%)	48 (24%)	16 (8%)	26 (13%)	34 (17%)	835.6
Shampo	145 (72.5%)	157 (78.5%)	102 (51%)	118 (59%)	105 (52.5%)	112 (56%)	123.1
Dithane	57 (28.5%)	53 (26.5%)	65 (32.5%)	32 (16%)	16 (8%)	18 (9%)	40.1
Formalin	72 (36%)	44 (22%)	32 (16%)	35 (17.5%)	22 (11%)	15 (7.5%)	36.6
Ethephon and CaC <sub>2</sub> combined	7 (3.5%)	5 (2.5%)	2 (1%)	Nil (0%)	Nil (0%)	Nil (0%)	2.3
Dithane and Formalin combined	14 (7%)	21 (10.5%)	12 (6%)	3 (1.5%)	Nil (0%)	Nil (0%)	8.3
Ethephon Dithane and Shampo combinedly	45 (22.5%)	32 (16%)	16 (8%)	27 (13.5%)	4 (2%)	Nil (0%)	20.6
Natural without any chemicals	55 (27.5%)	43 (21.5%)	98 (49%)	82 (41%)	95 (47.5%)	88 (44%)	76.8

**Table 2. Presence of health hazardous chemicals in ripe tomato samples at six districts of Chittagong division**

<b>Name</b>	<b>Chittagong</b>	<b>Feni</b>	<b>Noakhali</b>	<b>Rangamati</b>	<b>Bandar- bon</b>	<b>Khagrachori</b>	<b>Total /mean data</b>
Total samples	200	200	200	200	200	200	1200
Ethylene	12 (6%)	5 (2.5%)	8 (4%)	Nil (0%)	Nil (0%)	Nil (0%)	4.1
Ethephon	59 (29.5%)	62 (31%)	66 (33%)	32 (16%)	38 (19%)	16 (8%)	45.6
CaC <sub>2</sub>	55 (27.5%)	43 (21.5%)	34 (17%)	13 (6.5%)	18 (9%)	8 (4%)	28.5
Shampo	165 (82.5%)	142 (71%)	152 (76%)	103 (51.5%)	92 (46%)	74 (37%)	121.3
Dithane	42 (21%)	33 (16.5%)	63 (31.5%)	22 (11%)	16 (8%)	36 (18%)	35.3
Formalin	58 (29%)	46 (23%)	39 (19.5%)	33 (16.5%)	24 (12%)	53 (26.5%)	42.1
Ethephon And CaC <sub>2</sub> combined	14 (7%)	16 (8%)	22 (11%)	6 (3%)	Nil (0%)	Nil (0%)	9.6
Dithane and Formalin combined	25 (12.5%)	13 (6.5%)	2 (1%)	Nil (0%)	Nil (0%)	Nil (0%)	6.6
Ethephon Dithane and Shampo combinedly	40 (20%)	32 (16%)	55 (27.5%)	15 (7.5%)	16 (8%)	12 (6%)	28.3
Natural without any chemicals	35 (17.5%)	58 (29%)	48 (24%)	97 (48.5%)	108 (54%)	126 (63%)	78.6

**Table 3. Presence of health hazardous chemicals in ripe tomato samples at six districts of Sylhet division**

Name	Sylhet	Shunamgonj	Moulavibajar	Hobigonj	Total /mean data
Total samples	400	400	200	200	1200
Ethylene	38 (9.5%)	55 (13.75%)	23 (5.75%)	15 (3.75%)	32.7
Ethephon	92 (23%)	78 (19.5%)	42 (10.5%)	56 (14%)	67
CaC <sub>2</sub>	69 (17.25%)	72 (18%)	68 (17%)	27 (6.75%)	59
Shampo	248 (62%)	198 (49.5%)	105 (26.25%)	72 (18%)	155.7
Dithane	85 (21.25%)	98 (24.5%)	94 (23.5%)	121 (30.25%)	99.5
Formalin	122 (30.5%)	87 (21.75%)	125 (31.25%)	73 (18.25%)	101.7
Ethephon And CaC <sub>2</sub> combined	22 (5.5%)	16 (4%)	18 (4.5%)	Nil (0%)	14
Dithane and Formalin combinedly	32 (8%)	8 (2%)	Nil (0%)	Nil (0%)	10
Ethephon Dithane and Shampo combinedly	80 (20%)	77 (19.25%)	42 (10.5%)	52 (13%)	62.7
Natural without any chemicals	152 (38%)	202 (50.5%)	95 (23.75%)	128 (32%)	144.2

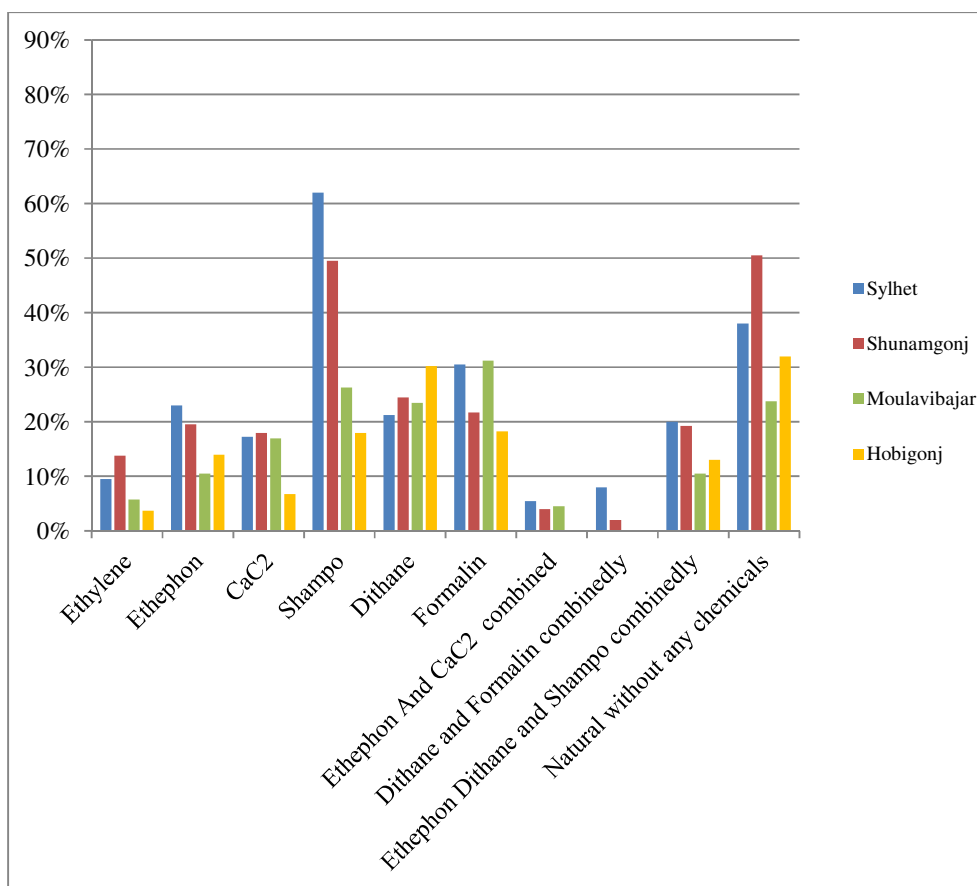


**Fig. 3. Presence of hazardous chemicals in ripe tomatoes in Chittagong division**

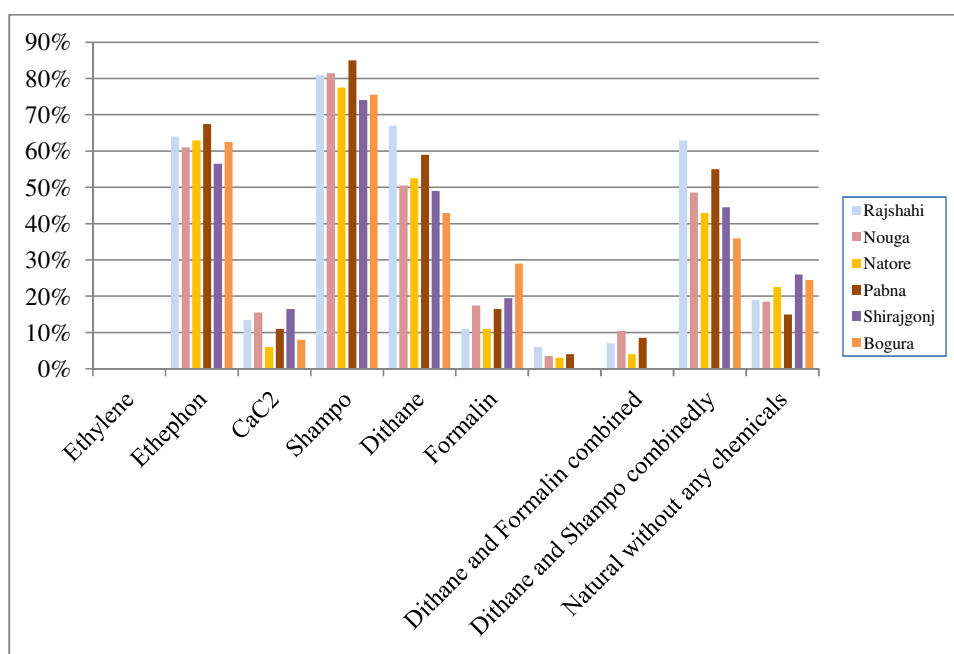
**Table 4. Presence of health hazardous chemicals in ripe tomato samples at six districts of Rajshahi division**

<b>Name</b>	<b>Rajshahi</b>	<b>Nouga</b>	<b>Natore</b>	<b>Pabna</b>	<b>Shirajgonj</b>	<b>Bogura</b>	<b>Total /mean data</b>
Total samples	200	200	200	200	200	200	1200
Ethylene	Nil (0%)	Nil (0%)	Nil (0%)	Nil (0%)	Nil (0%)	Nil (0%)	0
Ethephon	128 (64%)	122 (61%)	126 (63%)	137 (67.5%)	113 (56.5%)	125 (62.5%)	125.1
CaC <sub>2</sub>	27 (13.5%)	31 (15.5%)	12 (6%)	22 (11%)	33 (16.5%)	16 (8%)	23.5
Shampo	162 (81%)	163 (81.5%)	155 (77.5%)	170 (85%)	148 (74%)	151 (75.5%)	158.1
Dithane	134 (67%)	101 (50.5%)	107 (52.5%)	118 (59%)	98 (49%)	86 (43%)	107.3
Formalin	22 (11%)	35 (17.5%)	22 (11%)	33 (16.5%)	39 (19.5%)	58 (29%)	34.8
Ethephon And CaC <sub>2</sub> combined	12 (6%)	7 (3.5%)	6 (3%)	8 (4%)	Nil (0%)	Nil (0%)	5.5
Dithane and Formalin combined	14 (7%)	21 (10.5%)	8 (4%)	17 (8.5%)	Nil (0%)	Nil (0%)	10
Ethephon Dithane and Shampo combinedly	126 (63%)	95 (48.5%)	86 (43%)	110 (55%)	89 (44.5%)	72 (36%)	96.3
Natural without any chemicals	38 (19%)	37 (18.5%)	45 (22.5%)	30 (15%)	52 (26%)	49 (24.5%)	41.8

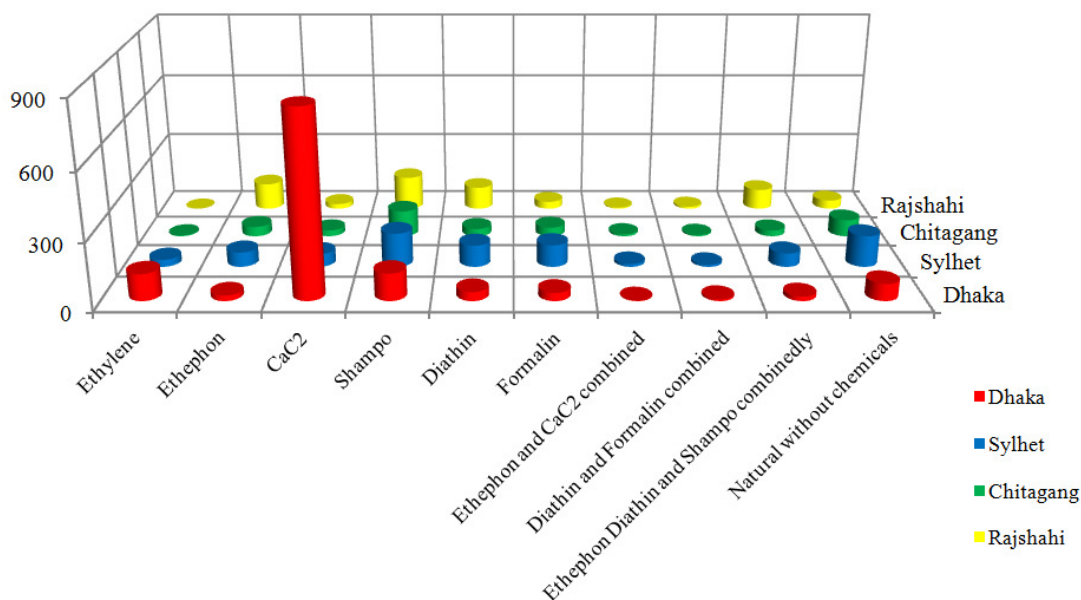




**Fig. 4. Presence of hazardous chemicals in ripe tomatoes in Sylhet division**



**Fig. 5. Presence of hazardous chemicals in ripe tomatoes in Rajshahi division**



**Fig. 6. Comparisons between the uses of different hazardous chemicals among the four divisions**

In the Rajshahi division unlike others, the presence of ethephon and formalin in tomatoes was very much high. About 60% or above tomatoes were contaminated with ethephon in almost all districts in Rajshahi. The content of CaC<sub>2</sub> is below 20% in almost all districts but dithane was also high comparing to the others divisions (Fig. 5).

In all division most of the tomatoes were highly contaminated with Shampoo (Tables 1-4) (Figs. 2-5).

Comparisons between the uses of different hazardous chemicals among the four divisions: From data presented in Tables 1-4, it was found that the use of CaC<sub>2</sub> in Dhaka division was much higher than the other divisions. The use of ethylene was also high in Dhaka. The use of Shampoo was almost nearly same in all divisions. On the other hand the use of formalin is slightly high in Sylhet division. Simultaneously the presences of natural tomato without treatment of any chemicals were also higher in Sylhet division. Ethephon treated tomato was higher in Rajshahi division (Fig. 6 above).

#### 4. CONCLUSION

From the comparison it can be concluded that the tomatoes of Dhaka's market is much more

adulterated with health hazardous chemicals such as CaC<sub>2</sub>, ethylene and formalin than the other divisions of Bangladesh. This study will be helpful for understanding the comparative uses and effects of hazardous chemicals on tomato ripening as well as on other fruits and vegetable of Bangladesh. Tomato is a rich nutrient containing vegetables having essential amount of vitamin, minerals as well as some precursor for hormone of human body. For its low cost with high nutritional value, it can be considered an important vegetable for the developing country like Bangladesh. So it is very necessary to keep away the tomatoes from contamination with health hazardous chemicals. For healthier and happier life, everybody should be concerned about it. The authority should take proper and necessary steps to prevent this bad practice as soon as possible.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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