

ORIGINAL ARTICLE

Knowledge, Attitude and Practice (KAP) Associated With Calcium Carbide (CaC₂) Used for Fruit Ripening among Mango Farmers, Farm Workers and Fruit Traders

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ABSTRACT

Introduction: Calcium Carbide (CaC₂) use for fruit ripening become dubious in recent years when various health related issues began to arise. This study aims to assess knowledge, attitude and practises (KAP) and health related to CaC₂ among mango farmers, staff/workers working in mango farms and fruits traders in Perak, Kedah and Perlis. **Methods:** All potential respondents in the study locations was invited to participate. Yes-no questions were used to assess KAP while structured questions were used to obtain socio-demographic data through face-to face interview. **Results:** The response rate for this study was 67.8% (n = 200). All respondents were male with the average age of 40.45 years old. Majority of them (67.5%) completed secondary school as their highest education level. Overall, less than half of the total respondents have appropriate KAP. Only job tenure significantly associated with the knowledge on the type of suitable PPE ($\chi^2 = 16.421$). Respondents with secondary or tertiary school of education level ($\chi^2 = 9.154$) and those with 1-5 years of job tenure ($\chi^2 = 10.932$) showed significantly better attitude on CaC₂ handling. Also, the total scores of knowledge significantly associated with attitude ($\chi^2 = 26.801$) and application of glove ($\chi^2 = 12.551$). In multiple logistic regression only respondents with the knowledge on type of PPE (OR = 6.30) will persist to use CaC₂. **Conclusion:** The KAP related to CaC₂ among respondents is low and their knowledge was significantly associated with their attitude and practice. Therefore, effective training and communication approach is warranted.

Keywords: Calcium carbide, Chemical fruits ripening, KAP

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INTRODUCTION

In Malaysia, the total area planted with mango is 5.816.4 hectare (1). The main areas of mango plantation on the North Region of Peninsular Malaysia includes Perak, Perlis and Kedah with total production (metric tons) in 2016 are 6377.1, 1388.1 and 298.6 respectively (Department of Agriculture, 2016). Mango is considered as seasonal fruits and like many other seasonal fruits, it cannot be attained at all times. Normally, naturally ripening fruits does not ripen uniformly and this situation makes it difficult for the marketing and distribution purposes. Thus, chemical ripening agents such as CaC₂, ethanol, methanol, ethylene glycol and ethephon (2) are used by farmers to accelerate the ripening process and provide a high return to the sellers. In Malaysia, mangoes are picked slightly unripe and then calcium carbide is applied. Calcium carbide (CaC₂) is widely used in Asian country since antiquity for ripening purposes (3).

Artificial fruits ripening become dubious in recent years when various health related issues began to arise (4). The use of carbide has a bad effect on the human health where it can affect them when inhaled. Health effects caused by CaC₂ include skin irritation which can cause rash and redness and lung irritation which initiate cough and/or shortness of breath (5). Pulmonary edema with acute shortness of breath may occur with higher exposure and if there are a repeated exposure, it can cause bronchitis with coughing, phlegm and/or shortness of breath (5). Acetylene generated from the CaC₂ reaction contain a trace of arsine and phosphine at a concentration of 3 ppm and 95 ppm, respectively (6). The existence of these impurities gives rise to the calcium carbide toxicity (7) especially if high amount of calcium carbide is applied on raw fruits. The major route of exposure for acetylene is by inhalation (7) and since it is found to be irritant to respiratory system (8), in a long run will cause respiratory depression, hypoxia, hypotension, convulsions, pulmonary edema and cardiac dysrhythmias (7).

Since there have been consistent previous findings on the detrimental health effect from CaC₂ exposure, study

on the knowledge, attitude and practice (KAP) related to CaC_2 handling among farmers is therefore crucial and will serve as an imperative awareness tool for policymakers to come out with a verdict on the enactment of rules and regulation on the handling of carbide especially in Malaysia. This KAP study will provide information on the knowledge about health hazards posed by this chemical and its impurities, changes in attitudes towards the application of safer method and variety of practices with regard to the management of CaC_2 and its impurities exposure. Therefore, the government and policymakers may utilize those findings to deliberate a law and legislative on the amount of CaC_2 applied onto fruits or at least a regulation on the use of proper personal protective equipment (PPE) while handling it. Currently in Malaysia, there are no act and regulations governing the use of CaC_2 in postharvest phase in agricultural sector either related to occupational safety or food safety. However, there is a regulation on phosphine exposure limit where the 8 hour-time-weighted average airborne concentrations value is 0.3 ppm as stated in the Occupational Safety and Health (Use and Standards of Exposure of Chemical Hazardous to Health) Regulations 2000 (9). The developing countries in South and East Asia like Bangladesh, India and Nepal have laws specific in prohibiting CaC_2 being used as a ripening agents either in preparing or selling and distributing of fruits ripened with this chemical (10).

A KAP survey is referring to a gathering of qualitative and quantitative information (11) from an explicit population on what they know about specified matter and how they react, comprehend and conduct themselves (12) via a set of questions in systematized questionnaire. In the present study, the KAP survey is design specifically to collect information about CaC_2 related topics. The knowledge explored in this study is refer to their understanding on the dangerous of this chemical to their health while the attitudes focused on their reaction either they will still use CaC_2 or other safer alternative when they already know the dangerous of this chemical and practice refers to the approaches they exhibit their knowledge and attitude through actions and in this study it refers to the use of PPE while handling the chemicals.

MATERIALS AND METHODS

The study populations were mango farmers, mango farm workers and fruit traders in Perak, Kedah and Perlis. This study was conducted in mango farms operated by farmers on a land provided by the government agencies, mango farms operated by government agencies and mango farms operated by individual farmers on private land. For fruit traders, the respondents were among the entrepreneurs who are registered with Fresh Fruit Stall program under the Federal Agricultural Marketing Authority (FAMA) and also individual fruit traders who are not registered with any government agencies. There were 200 respondents at the time this study was carried

out with 118, 56 and 26 respondents were from Perak, Kedah and Perlis respectively. Their total number is small and they are scattered in different locations throughout Perak, Perlis and Kedah. This study has been carried out at 26 different locations in Perak, Perlis and Kedah. The North region were chose because the main areas of mango planted in Malaysia are on the Perak, Perlis and Kedah with total production (Metric Tons) in 2016 are 6377.1, 1388.1 and 298.6 respectively (Department of Agriculture, 2016).

The sampling criteria for this preliminary study are male with age between 18 - 70 years old who are involved directly or indirectly with mango ripening process using calcium carbide. Face to face interviews with the respondents was carried out using a set of newly developed questionnaire. The newly developed questionnaires are consists of sociodemographic, working characteristic and Knowledge, Attitude and Practice (KAP). The types of questions used were Yes/No type and multiple choice questions. All respondents were assisted in answering the questions in the questionnaires. Questionnaire used in this study were tested using test-retest reliability where it was analyzed statistically using Pearson correlation test. The correlation value of the pre-test for sociodemographic factors, working characteristic and KAP were above 0.70.

For KAP, the questions were consisted of knowledge on the recommended quantity of CaC_2 used, knowledge on the effect of CaC_2 to health, knowledge on other safer ripening method, knowledge on route of exposure and knowledge on personal protective equipment (PPE) while for attitude, respondents were asked on the continuation of using CaC_2 if they knew or told how it may affect human health. Respondents were also inquired on the use of PPE when they handle CaC_2 .

The ethical approval of this study was obtained from Ethic Committee, Universiti Putra Malaysia (FPSK (exp16) p100).

RESULTS

Table I shows that the response rate for this study was 67.8 % (N=200). The highest response was among farmers, farm's worker and fruit trader in Perak (112%) and the lowermost response was in Kedah (29%). The average age of the respondents was 40.45 years old (N=200).

There were four categories of respondent's age in this study and the categories are 18 – 28(20%), 29 – 39(30.5%), 40 – 50(26.5%) and above 50(23%). Analysis of the respondent's educational level shows that 135 (67.5%) of them completed secondary school, 38 (19%) had tertiary education, 21 (10.5%) finished primary school and 6 (3%) were unschooled. For respondent's smoking status, 100 (50%) of them were classified as

Table I: Response of farmers and fruit traders in Perak, Kedah and Perlis

Region	Respondents	Estimated number of respondents	Actual number of respondents	%
Perak	Farmers/fruit traders/ farm workers	105	118	112
Perlis	Farmers/fruit traders/ farm workers	100	56	56
Kedah	Farmers/fruit traders/ farm workers	90	26	29
Total		295	200	67.8

smoker and the remainder were non-smoker (50%). The mean for duration of employment were 7.54 (n=200) and 21(10.5%) of them have been working for less than 1 year, 76 (38%) for 1 – 5 years, 59 (29.5%) for 6 – 10 years and 44 (22%) have been employed for more than 10 years.

Knowledge of farmers and farm workers on CaC₂

The knowledge of the respondents (n=200) on CaC₂ and health is illustrated in Table II. A total of 48 respondents (24%) were aware on the recommended quantity of CaC₂ that should be applied in fruits ripening which is 0.3 – 10g of carbide for each kg of yields (Rohani, 1999). When enquired on the possible health effects of CaC₂ to human health, only 51 respondents (25.5%) correctly identified the effects which were cough (7.5%), shortness of breath (7%), effect to respiratory system (3.5%), chest tightness (1.5%), skin (0.5%), frequent thirst (2%), headache (0.5%) and multiple effects which consist of cough, headache, shortness of breath, chest tightness and skin (3%).

In addition, respondents also indicated their knowledge on the alternative safer methods for ripening purposes which included the use of ethylene chamber (10%), use of other natural sources (11%) such as rice, apple fruit,

Table II: Knowledge of respondents on CaC₂ (N = 200)

Knowledge	Frequency, (%)		Cumulative frequency, (%)	
	Yes	No	Yes	No
Recommended quantity of CaC₂ used	48 (24)	152 (76)	48 (24)	152 (76)
Effect of CaC₂ to human health:				
- Respiratory system				
- Shortness of breath	7 (3.5)	149 (74.5)	51 (25.5)	149 (74.5)
- Cough	14 (7)			
- Chest tightness	15 (7.5)			
- Skin damage	3 (1.5)			
- Frequent thirst	1 (0.5)			
- Multiple effect	4 (2)			
- Headache	6 (3)			
	1 (0.5)			
Other safer ripening method used:				
- Ethylene gas	20 (10)			
- Natural ripening	48 (24)	110 (45)	90 (45)	110 (45)
- Use natural resources	22 (11)			
Route of entry:				
- Inhalation	91 (45.5)	106 (53)	94 (47)	106 (53)
- Ingestion	1 (0.5)			
- Inhalation and ingestion	2 (1)			
Knowledge on PPE	133 (66.5)	67 (33.5)	133 (66.5)	67 (33.5)

yeast and leaf and apply natural ripening (24%) which is without the use of any ripening agent. Table II also exhibits the possible route of exposure distinguished by the respondents where inhalations were the most responded which was 45.5%. Furthermore, a total number of 133 respondents (66.5%) knew about the type of PPE that can be use such as mask and glove.

Attitudes of farmers and farm workers on the use of CaC₂

There were 86 (43%) respondents stated that they will discontinue applying CaC₂ for fruit ripening after knowing that it is hazardous to their health. However, a total of 114 (57%) respondents will still continue using CaC₂ as a fruits ripening agent even if they knew the possible harmful effect of CaC₂ to human health. The reasons specified by the respondents for resuming use of CaC₂ were shown in Table III. It was found that cost factor was the primary reason why they choose to continue using CaC₂ (24.5%) even though they know that it is hazardous. Twenty percent of them claimed that they are still using CaC₂ simply because they just follow the instruction by their superior/farm manager/supervisor.

Table III:The attitudes of respondents on the use of CaC₂ (N = 200)

Justification	Frequency, (%)		Cumulative frequency, (%)	
	Yes	No	Yes	No
Cheap	49 (24.5)			
Easily available	6 (3)			
Follow instruction	40 (20)			
Uniform/even ripening	12 (6)	86 (43)	114 (57)	86 (43)
With the use of PPE	5 (2.5)			
Faster process	1 (0.5)			
Enhance fruit's aroma	1 (0.5)			

Practices towards the use of CaC₂

Protective measures used by respondents during application of CaC₂ is shown in Table IV. Overall, only 70 (35%) and 74 (37%) used face mask and glove, respectively, while handling CaC₂ and all of the respondents did not eat and drink during the process.

Table IV: The frequency of respondents who applied protective measures when handling CaC₂ (N = 200)

Protective measures	Frequency	%
Wear glove:		
Yes	74	37
No	126	63
Wear mask:		
Yes	70	35
No	130	65
Eating while handling CaC₂:		
Yes	0	0
No	200	100
Drinking while handling CaC₂:		
Yes	0	0
No	200	100

The relationship between sociodemographic factor and work characteristic with knowledge

The findings of this study, among all variables related to socio-demographical factors and work characteristics, only the duration of employment was found to be significantly associated with the knowledge on the type of suitable PPE ($\chi^2 = 16.421, p < 0.05$).

The relationship between sociodemographic factor and work characteristic with attitude

There was a significant association between education level ($\chi^2 = 9.154, p < 0.05$) and duration of employment ($\chi^2 = 10.932, p < 0.05$) with attitudes. Respondents with the secondary or tertiary as their highest education level had better attitude on the practice of good CaC₂ handling than those who were unschooled or who completed primary school as their highest level of education. Those who has been working for 1-5 years shows better attitude than the other age groups (Table V).

Table V: Relationship between sociodemographic factor and work characteristic with attitude (N=200)

Variables	Attitudes (f (%))	
	Yes	No
Age:		
18-28	21(10.50)	19(9.5)
29-39	33(16.5)	28(14)
40-50	31(15.5)	22(11)
Above 50	29(14.5)	17(8.5)
Total	114(57)	86(43)
χ^2 (p-value)	1.274 (0.735)	
Education level:		
Primary	16(8)	5(2.5)
Secondary	70(35)	65(32.5)
Tertiary	22(11)	16(8)
Unschooled	6(3)	0(0)
Total	114(57)	86(43)
χ^2 (p-value)	9.154(0.027)*	
Duration of employment:		
Less than 1 year	14(7)	7(3.5)
1 -5 years	41(20.5)	35(17.5)
6-10 years	26(13)	33(16.5)
More than 10 years	33(16.5)	11(5.5)
Total	114(57)	86(43)
χ^2 (p-value)	10.932 (0.012)*	

*Significant at p < 0.05

The relation between sociodemographic and work characteristic with the practice on PPE

This study also shows that there was no association between age, education level and working duration with the application of mask and glove when handling CaC₂.

The relationship between knowledge with attitude and practice

Results indicated that there was no association between knowledge on the effect of CaC₂ to health with attitude and practice. Nevertheless, knowledge on route of

exposure ($\chi^2 = 4.509, p < 0.05$) and type of PPE used ($\chi^2 = 30.299, p < 0.05$) has a significant association with respondent's attitude. This study also disclosed there is a significant association between the knowledge that respondents have on the type of PPE used with the practices of using mask ($\chi^2 = 4.104, p < 0.05$) and glove ($\chi^2 = 9.228, p < 0.05$). Total scores on knowledge showed a significant association with attitude ($\chi^2 = 26.801, p < 0.05$) and application of glove ($\chi^2 = 12.551, p < 0.05$) (Table VI).

Table VI: Relationship between knowledge with attitude and practice (N=200)

Variables	Knowledge							
	Bad effects of CaC ₂ to human health		Route of exposure		Type of PPE		Total knowledge	
	χ^2	p (95% CI)	χ^2	p (95% CI)	χ^2	p (95% CI)	χ^2	p (95% CI)
Attitude of persistence on the use of CaC ₂ for ripening purposes	0.123	0.726	4.509*	0.034	30.299*	<0.001	26.801*	<0.001
Application of mask	0.003	0.959	0.848	0.357	4.104*	0.043	4.734	0.192
Application of glove	0.085	0.770	1.533	0.216	9.228*	0.002	12.551*	0.006

*Significant at p < 0.05

A multiple logistic was run to identify which knowledge contribute the most on the persistent use of CaC₂ for ripening purposes. Results indicated that knowledge on route of exposure and total knowledge were not significantly associated with respondent's attitude. However, knowledge on type of PPE used (OR = 6.300, p = <0.001) have a significant association with attitudes. The Hosmer and Lemeshow test revealed that the model was a good fit for the data ($\chi^2 = 7.502, p = 0.112$). (Table VII).

Table VII: Summary of multiple logistic regression for predicting the most contributable knowledge towards respondent's attitude.

Variables	B	S.E	Wald	p-value	df	Odds ratio (OR)	95% CI for OR	
							Lower	Upper
Knowledge on route of exposure	0.027	0.516	0.003	0.958	1	1.027	0.373	2.827
Knowledge on type of PPE	1.841*	0.497	13.726	<0.001	1	6.300	2.379	16.681
Total knowledge	-0.083	0.356	0.054	0.816	1	0.920	0.458	1.850

*Significant at p < 0.05

DISCUSSION

The current study depicts the knowledge, attitudes and practice associated to carbide use among farmers in Perak, Kedah and Perlis. The highest response rate of this study was located in Lekir, Perak. This is likely because Lekir is the location of the largest mango farm (Chokanan type) in Perak where farmers grow mangoes on land provided by the Department of Agriculture under the Taman Kekal Pengeluaran Makanan (TKPM) program (13). The total area of TKPM Lekir is 149 hectares (13) and the land area for mango plants is 80 hectares with 11 participants (14). The respondents among fruit traders who are registered with Fresh Fruit Stall program located in Perak were also high because they had been notified earlier by the officer from FAMA Perak regarding this study and were requested to present during the survey.

A low level of knowledge on carbide's recommended quantity, harmful health effect to human, alternative ripening method and route of exposure among respondents were revealed in this study. The depleted percentage of respondent's knowledge on the recommended quantity of carbide used for ripening may be due to the lack of exposure concerning this chemical as the information on the suggested amount can only be acquired from a book or journal and from training, courses or seminar attended. Moreover, there is no explicit enforcement on the quantity or amount of CaC_2 shall be used in fruits ripening practice and this may contribute to their ignorance.

High percentage of respondents was more knowledgeable on inhalation as a route of exposure for CaC_2 than other route of exposure. This knowledge may be derived from their experience during the carbide's wrapping and ripening activity as interviewed further, they noticed a garlic odor throughout the process. In addition, this is consistent with a statement issued by the Public Health England stating that the major route of exposure for acetylene released from the carbide's reaction is through inhalation (7).

Respondent's knowledge about the health effect of carbide were reported high for shortness of breath and cough compared to other symptoms. This maybe because the respondents were able to relate the route of exposure of carbide with the effect on respiratory system as well as they may experience themselves the effect on the use of carbide and this is coherent with a study conducted by Siddiqui and Dhua where they identified symptoms that may occur momentarily after being exposed to CaC_2 which were shortness of breath, wheezing, cough and throat sores (15).

For attitudes, the main justification for the continuity of using carbide as acetylene source is the cost issue. This is because it can easily be purchased from rural

shops for RM5.50 per kg (16) and make it a very admired material used among farmers (17). Although they were aware about the safer alternative method which is the ethylene gas chamber, most of them are incapable in term of financial due to high infrastructure, operative and maintenance costs and according to them it is not worth their sales.

The use of face mask and glove among farmers when handling carbide was quite low which were 35% and 37%, respectively. Although 97% of them are literate, but their knowledge on the effect of carbide to human health was low and this may resulting to low level use of PPE. When asked further on the impurities in the carbide that can cause a harmful health effect, all of the respondents were unaware on the presence of arsenic and phosphorus in the carbide and this may lead to a poor use of PPE. The low level use of PPE by respondents was corresponding with the study conducted previously on 403 rattan craftsmen on the use of sulphur as bleaching agent in Vietnam. Face to face interview indicated that the practice on the using of at least one type of PPE was 29% (18). From this study, the low level use of PPE by respondents was corresponding with the low level of good knowledge and good practice which was 3.72% and 4.22% respectively (18). However, other factors that may contribute to the lower percentage of workers who wore PPE were discomfort, cost, carelessness and inadequate provision of resources (19).

Results of the present study also found that a total of 70 (35%) and 74 (37%) respondents were wearing mask and glove, respectively, when handling CaC_2 . However, it was discovered that there is no association between age, education level and duration of employment with knowledge on quantity of CaC_2 used for ripening, knowledge on the bad effect of CaC_2 to health, knowledge on other safer ripening method, knowledge on route of exposure and the application of PPE. These findings reflects that respondent's experience, education and competency does not have an influence on the awareness of the chemical that they handle and the protection measures that they can utilize. This probably due to the existent of knowledge gap on the harmful impurities in the CaC_2 and thus, lead to the extension of practice gap. Interestingly, there's a significant association between duration of employment with the knowledge on the type of PPE used. From this study it showed that respondents who were employed for a longer period (more than 6 years) being less aware on the type of PPE that can be used to protect themselves. This probably because the period of employment may encourage them to assume that they have adequate experienced and competency to handle chemical without proper protection. Thus, the knowledge on type of PPE maybe not crucial for them to appreciate.

In the multiple logistic regression, results show the positive association between respondent's knowledge

on type of PPE with their attitude on the persistent use of CaC₂ for fruits ripening. Results indicated that respondents who know about PPE are persistent to continue using CaC₂ for ripening process than respondents who did not know about PPE which shows that they possess a good perception on how PPE can be utilized to minimize the harmful effect of CaC₂.

CONCLUSION

This is a first KAP survey on the use of CaC₂ in fruits ripening process. Findings indicated that, less than half of the total respondents have appropriate knowledge, attitude and practice on the safe handling of CaC₂ even though it is evident in this study that knowledge on CaC₂ use is significantly associated with their attitude and practice in CaC₂ handling. Results also showed that respondent's experience, education and competency does not have an influence on the awareness of the chemical that they handle and the protection measures that they can utilize. The knowledge gap or behavioral patterns can be identified and expedite the actions to protect worker's health. The information gathered from the survey may be used to enhance a proper and effective communication approach so that the message regarding the safer way to ripen fruits can be delivered efficiently to the workers. Besides, the finding for this study will be beneficial where it can be used to increase farmer's awareness on the health impact of the use of CaC₂ to workers and to encourage workers to improve good work practice via the use of protective personal equipment (PPE) when handling CaC₂. Moreover, it can be utilized to implement positive mind-sets and behavior concerning the potential health associated with CaC₂ and phosphine poisoning plus it can be used to estimate resources needed for worker's protection. Thus, from this study, the KAP survey provides a solution for farmers to make a tactical decision on several issues such as the type of PPE that can be utilized and other safer alternative ripening method. This study also provided a proper communication channel for the farmers to deliver the safety implications to their workers through training program, worker's health monitoring program and prevention program by the use of proper PPE.

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