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RESEARCH ARTICLE

Safety Behavior Predictors Related to the Food Safety of Greenhouse Products among the Greenhouse Owners Based on Protection Motivation Theory

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Abstract:

Objective:

The purpose of this study was to determine the safety behavior predictors related to the food safety of greenhouse products among the greenhouse owners of Jiroft city based on the Protection Motivation Theory (PMT).

Methods:

A cross-sectional study was conducted with a descriptive-correlation approach in 2018 on 228 greenhouse owners. A researcher-made questionnaire that included demographic variables, PMT structures, and safety behavior was administered.

Results:

Of the surveyed greenhouse owners, 98.2% were men. The participants were aged from 21 to 70 years. The mean scores of all PMT constructs other than response costs, and safety behaviors other than that of preventing the prevalence of pests were at a moderate level. The prediction rate of safety behaviors by PMT constructs was 74.4%. Meanwhile, perceived costs' construct ($\beta = -0.349$), response efficacy ($\beta = 0.251$), and protection motivation ($\beta = 0.424$) had important roles.

Conclusion:

Given the predictive power of PMT constructs for safety behaviors related to food safety, educational interventions based on this theory are required.

Keywords: Food safety, Behavior, Pest control, Self-efficacy, Reward, Motivation.

Article History

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1. INTRODUCTION

Considering population growth and the need to produce more food [1], food safety has gained increasing importance to control and prevent food-borne diseases [2]. An important point in this regard is the use of pesticides in greenhouse production. Pesticides should necessarily be used with precise

observance of safety methods and greenhouse health-related principles to reduce or remove the pesticides' harmful effects [3].

In one study, the results showed that 31.81% of samples were contaminated with pesticides, which exceeded the maximum allowable contamination rate [4]. In another study, edible mushrooms were contaminated with the residues of the pesticides which were significantly higher than the limit set by the European Union [5]. In Mansour's study, the residual pesticides in greenhouse cucumber products were generally at

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peak level in certain seasons of the year [6].

The measurement of residual pesticides in agricultural products needs special laboratory procedures that are costly and time-consuming [7]. So, the best way to ensure food safety is to focus on cost-effective management to prevent food safety risks in the food chain from production to consumption [2].

Thus, the scientific use of pesticides in lower volumes and lower levels in greenhouses is crucial. These considerations save production costs, control plant diseases better, produce healthier products with less residual pesticides, and preserve the environment [8]. This topic is in the context of a new strategy entitled Integrated Pest Management (IPM). In other words, the concept of IPM includes all methods of control and application of chemical combat as the last strategy [9]. By IPM program the use of pesticides can be considerably reduced without affecting the products or the farmers' profits [10]. So, to make fundamental decisions in solving public health and food safety challenges, it is necessary to use the present capacity of research-based evidence [2]. One of the important issues in this respect is observance of health-related behaviors to food safety [11].

To adopt consistent behaviors with technology and new methods, education is essential. The effectiveness of education depends on the application of the appropriate models and theories. Motivational theories focus on how different factors affect human behavior [12]. One of these theories is the Protection Motivation Theory (PMT), which is used to predict how different factors affect greenhouse owners' motivation to protect greenhouse produce from harmful agents. This theory is applied to predict the individuals' protection motivation in adopting protective behaviors [13] when face active environmental threats or messages that notify these threats. These people adopt two processes of threat appraisal or coping appraisal [14].

Assessing threats consists of perceived threats (perceived vulnerability and severity) and perceived rewards. Coping appraisal consists of perceived efficacy (self-efficacy and response efficacy) and perceived costs [13].

Protection motivation is not observable directly but is deduced from the individuals' statements and opinions. It is represented with an intention profile that is considered as a significant predictor of behavior [14] (Fig. 1).

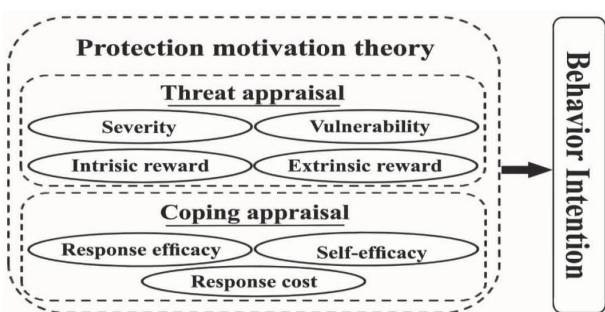


Fig. (1). Protection motivation theory (adopted from source number 13).

So far, several studies have been conducted using PMT in

connection with various topics, including healthy food choices [15], skin cancer in farmers [16], behaviors related to the reduction of drought effects on agriculture [17], and preventive behaviors of different diseases and injuries [13, 18]. But no study has ever been carried out or been available to researchers on the topic of the current study. So, this study aimed to investigate predictors of safety behavior related to the health safety of greenhouse-grown produce in Jiroft city based on PMT among greenhouse owners.

2. MATERIALS AND METHODS

This cross-sectional study was carried out in 2018 through a descriptive-correlation approach.

In this study, a relative stratified random sampling was applied. From each greenhouse, based on the inclusion criteria, Greenhouse owners who were from Jiroft city or lived in the area for more than 2 years and had at least 2 years of greenhouse experience were included in the study. Greenhouse owners with less than two years of greenhouse experience were excluded from the study. According to the pilot study conducted on 30 members of the goal population and the sample size formula; $n = Z^2 S^2 / d^2$, $z = 1.96$, $s = 10$, and $d = 1.3$, 228 participants were supposed to enter the study. In order to avoid dropouts, 246 participants arrived, among which 18 people were excluded due to lack of one or more inclusion criteria or not completing some questionnaire questions due to unwillingness to answer some questions. Questionnaire were asked by the researcher to the greenhouse owners and in the greenhouse and were marked in the appropriate place. Each question was clearly asked to study the participants and the options of the questions were explained to them.

A questionnaire that consisted of three parts was applied to collect data. The first part included demographic information and had nine questions. The second part consisted of 31 items relating to constructs of PMT that were scored over a five-point Likert scale. PMT consisted of eight constructs that are explained in the following: perceived vulnerability, perceived severity, perceived costs, perceived rewards, self-efficacy, response efficacy, fear and protection motivation with scores from 1 to 5; and the three part consisted of 47 items relating to safety behaviors through a five-point Likert scale from *always* to *never*) with four dimensions. The dimensions of safety behaviors included preventing the spread of pests, using safer methods, and biological control, wise application of low-risk pesticides, restricting application of moderate-risk pesticides, and finally not using high-risk pesticides. (Very few participants knew low-risk, moderate-risk and high-risk pesticides).

In order to divide pesticides into three groups of low-risk, moderate-risk, and high-risk, the Pesticides' Classification Guide File (2009) issued by the World Health Organization (WHO) was used [19].

The validity of the questionnaire was achieved through content validity by applying the opinions of a panel of experts. To assess the reliability of the questionnaire, Cronbach's alpha score was calculated to be higher than 0.72 for all PMT constructs and behavior. As a result, the data were analyzed by SPSS software (v. 20) through the application of descriptive statistic tests for the demographic variables and the PMT constructs' scores. Spearman correlation tests were used to

estimate the correlation between PMT constructs and demographic quantitative variables and constructs. The Mann–Whitney U and Kruskal–Wallis tests were used to measure the relation between the demographic variable and constructs of theory. Path analysis was performed using AMOS software (v. 20) to determine the predictors of safe behaviors by using theoretical constructs. The significance level in this study was 0.05.

3. RESULTS

In the current study, 98.2% of participants were male. Most

of them (55.7%) were in the age range of 26 to 40 years. Most of them (88.6%) said that they had never participated in educational sessions related to pest management and food safety (Table 1).

The workers' obtained scores of PMT were moderate, achieving a score of 50% to less than 75% of the attainable score (except regarding perceived costs, which was weak, achieving a score more than 75% of the attainable score). The safety behavior dimensions were also moderate (except regarding the prevalence of pests, which was weak) (Table 2).

Table 1. Demographic characteristics of greenhouse owners' participation in this study.

Variable	Number (percent)		P-value
Age	Under 25	16 (7)	0/000
	26-40	127 (55.7)	
	41-60	66 (28.9)	
	Above 60	19 (8.3)	
Gender	Male	224 (98.2)	0/000
	Female	4 (1.8)	
Marital status	Single	167 (73.2)	0/000
	Married	61 (26.8)	
Monthly income	Less than 500 \$	89 (39)	0/022
	From 500 to 1000 \$	81 (35.5)	
	Higher than 1000 \$	58 (25.4)	
Area under cultivation	Less than 2 hectares	98 (43)	0/034
	More than 2 hectares	130 (57)	
Literacy	Illiterate	95 (41.7)	0/000
	High school and less	90 (39.5)	
	Associate Degree	30 (13.2)	
	Bachelor and above	13 (5.7)	
Greenhouse ownership period	Under 5 year	123 (53.9)	0/233
	Above 5 year	105 (46.1)	
Training	Yes	26 (11.4)	0/000
	No	202(88.6)	
Product type with the largest area under cultivation and production	Cucumber	140 (61.4)	0/000
	Tomato	38 (16.7)	
	Eggplant	20 (8.8)	
	Strawberry	15 (6.6)	
	Others	15 (6.6)	

Table 2. Median, Interquartile range, Range, Score range of protection motivation attained score, and reported safety behavior dimensions in greenhouse owners.

Construct	Median	IQR1	Range	Score range
Perceived vulnerability	13	12.75	16	4-20
Perceived severity	12	7.75	12	3-15
Perceived rewards	8	4	8	4-10
Response costs	16	6	16	4-20
Fear	19.50	10	20	5-25
Self-efficacy	23	8	24	6-30
Response efficacy	22	9	24	6-30
Protection motivation	4	3	4	1-5
Safety behaviors	136.5	14	49	48-240

(Table 2) contd.....

Construct	Median	IQR1	Range	Score range
Preventing the prevalence of pests, using safer and biological control methods	72	12.75	37	29-145
Wise use of low-risk pesticides	19	8	17	6-30
Restriction of pesticides with medium risk	28	5	13	9-45
Avoiding use of hazardous pesticides	9	3	9	3-15

Interquartile Range (IQR)

Table 3. Correlation matrix among examined constructs in participants (n = 229).

Constructs	Perceived Vulnerability	Perceived Severity	Response Costs	Perceived Rewards	Fear	Self-efficacy	Response Efficacy	Protection Motivation	Safety Behaviors
Perceived vulnerability	1	-	-	-	-	-	-	-	-
Perceived Severity	0.601**	1	-	-	-	-	-	-	-
Response costs	-0.296**	-0.388**	1	-	-	-	-	-	-
Perceived rewards	-0.071	-0.243**	0.301**	1	-	-	-	-	-
Fear	0.574**	0.730**	-0.458**	-0.281**	1	-	-	-	-
Self-efficacy	0.455**	0.498**	-0.395**	-0.240**	0.532**	1	-	-	-
Response efficacy	0.421**	0.527**	-0.546**	-0.296**	0.545**	0.579**	1	-	-
Protection motivation	0.493**	0.645**	-0.591**	-0.337**	0.712**	0.595**	0.687**	1	-
Safety behaviors	0.442**	0.545**	-0.697**	-0.288**	0.611**	0.537**	0.754**	0.802**	1

*P-value<0.05 **P-value<0.01

There was a direct and significant correlation between all constructs of PMT and safety behavior (p < 0.01) other than between vulnerability and perceived rewards (Table 3).

There were significant relationships between individuals' education and response efficacy (P = 0.016), protection motivation (p = 0.048), and behavior (p = 0.002). There was also a significant relationship between the history of participation in educational sessions related to the production of healthy products and response efficacy (p = 0.011), protection motivation (p = 0.005), and behavior (p < 0.001). There was a significant inverse correlation between monthly

income and vulnerability (r = -0.202, p = 0.002), severity (r = -0.167, p = 0.012), fear (r = -0.162, p = 0.015), self-efficacy (r = -0.150, p = 0.023), response efficacy (r = -0.200, p = 0.002), and behavior (r = -0.181, p = 0.006).

Response costs, response efficacy, and protection motivation had direct effects on safety behaviors (Table 3).

Fig. (2) shows that the PMT constructs predict 74% of the variance in safety behaviors. Among these constructs, protection motivation (β = 0.413), response costs (β = -0.350), and response efficacy (β = 0.242) had more significant roles than the others (Table 4).

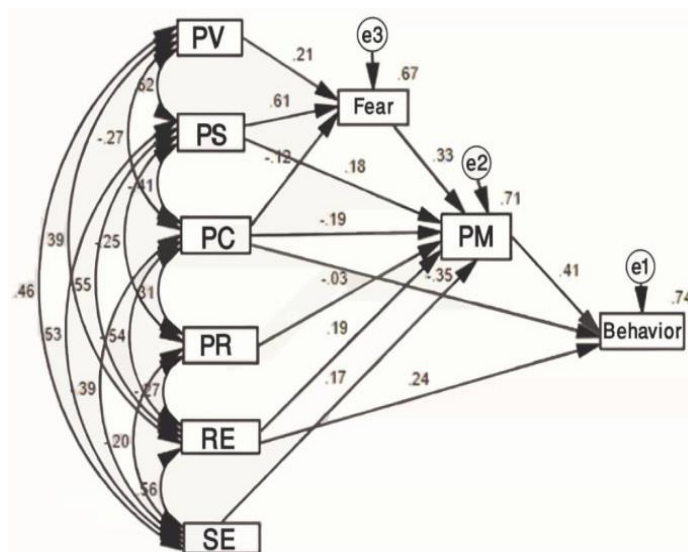


Fig. (2). Modified model for safe behavior of greenhouse owners related to the food safety of greenhouse products.

Table 4. Direct and indirect effects of variables on safety behaviors.

Variables	Standardized Direct Effects	Standardized Indirect Effects	Total Effects
Perceived vulnerability	-	0.029	0.29
Perceived severity	-	0.158	0.158
Response costs	-0.350	-0.095	-0.445
Perceived rewards	-	-0.013	-0.013
Fear	-	0.134	0.134
Self-efficacy	-	0.069	0.069
Response efficacy	0.242	0.077	0.319
Protection motivation	0.412	-	0.412

Table 5. Statistical indicators of the adjusted model.

RMSEA2	NFI3	IFI4	CFI5	GFI6	CMIN7	DF8	CMIN/DF9	P-value	χ^2
0.000	0.995	0.999	0.999	0.994	6.843	10	0.684	0.740	6.843

² Root Mean Square Error of Approximation (RMSEA)

³ The Normed Fit Index (NFI)

⁴ Increasing Fitness Index (IFI)

⁵ The Comparative Fit Index (CFI)

⁶ The Goodness of Fit Index (GFI)

⁷ Chi-Square Statistics

⁸ Degrees of Freedom (DF)

⁹ Minimum Discrepancy per Degree of Freedom (CMIN/DF)

According to Table 5, the statistical indicators of the adjusted model show a reasonable adjustment.

In this shape, PV = Perceived Vulnerability, SE = Self-Efficacy, RC = Response Costs, PR = Perceived Rewards, PS = Perceived Severity, PM = Protection Motivation.

4. DISCUSSION

The aim of this study was to determine the predictors of safety behavior relating to health and food safety predictors of greenhouse products among Jiroft city greenhouse owners based on PMT.

Since pesticides come with a lot of complications, including increased pesticide resistance, the application of chemical pesticides to fight pests is useful only when other methods are not responding [20].

One of the important benefits resulting from this practice is the inconsequential level of pesticide residue in products, thus making this produce safer for consumption [21]. So, observance of safety behaviors is necessary to provide healthy products, particularly when using alternative methods to chemical pesticides for destroying pests [22].

In this study, the mean scores of safety behaviors relating to the health of greenhouse products in preventing the spread of pest's dimension, and the application of safer and biological control methods were weak.

In the study conducted by Ghasemi, farmers used chemical pesticides excessively and most of them sent their products to the market shortly after pesticide spray [23].

In this study, other than the perceived costs that received weak scores, the mean scores of other PMT constructs were moderate.

Threat appraisal includes high perceived vulnerability and severity and low perceived rewards.

Coping appraisal consists of high self-efficacy and response efficacy, but low perceived response costs [13].

In the current study, greenhouse owners had moderate perceived rewards and moderate perceived vulnerability and severity; so, the situation of their threat appraisal for observance of safety behaviors related to greenhouse products' health was not desirable. Their perceived response cost was high, though their self-efficacy and response efficiency were moderate. Consequently, their coping appraisal did not have a desirable situation.

As a result, it can be said that the participants' protection motivation situation was not suitable and they should not be expected to observe safety behaviors related to the health of greenhouse products.

The results of the study conducted by Chen showed that if people understand that they are vulnerable to problems threatening food safety, their threat appraisal will lead to an increase in protection motivation. If they perceive a high self-efficacy for removing the problems caused by food safety, their degree of coping appraisal and their protection motivation will increase [14].

Heong indicated that the perceived benefits of pesticides were directly related to their application and the perceived severity resulted from the danger of pests in agriculture [24].

Many farmers decided to use pesticides based on their perception of the potential harms and losses caused by pest species. They often thought that the initial severity of damage to products was very high and decided to spray soon [25].

In the present research, while there was a reverse

significant correlation among income and the constructs of PMT (except for response costs and perceived rewards) and safety behaviors related to the health of greenhouse products, in the Keshavarz [17] study, there was a significant direct relationship among response efficacy, perceived severity, perceived vulnerability, self-efficacy, and income with environmental behaviors associated with drought.

Perhaps the difference between this study and Keshavarz's [17] research can be explained in this way: To observe the behaviors associated with drought, individuals may not have perceived that they can manage drought's problems more easily by applying funds, while greenhouse farmers think prevention of pests by IPM will result in more time and effort being spent and less income being received. They also believe that with the widespread use of chemical pesticides, less time and energy will be spent and more income will be earned. In the current study, rotation motivation, response costs, and response efficacy predicted 74.4% of safety behaviors. From the above results, it can be concluded that any cost perceived by the greenhouse farmers as a barrier to safety behaviors can be considered as an important factor in the rejection of safety behaviors. Also, the response efficacy of IPM technology is another important factor for the acceptance of this technology.

The results of a research indicated that financial matters are the most important factors in the rejection of the IPM technology [26]. Heong also reported that for 89% of farmers, pesticide spraying or not spraying depends on the costs of pests and workers [25].

Milne's meta-analysis showed that coping appraisal components in PMT are stronger predictors than threat appraisal for the implementation of health-related behaviors [27]. From the coping components in the current study, the scores of self-efficacy and response efficacy were not acceptable and the scores of perceived costs were poor. This issue may have caused poor safety behaviors related to food safety, especially in the dimension of using safer biological control methods. About the limitations of this study, it can be mentioned that observing safety behaviors associated with food safety was impossible and instead, a self-report was applied.

CONCLUSION

The results showed that the scores of PMT constructs and safety behaviors associated with food safety are not acceptable. So, It is necessary to take various educational and health promotion measures to ensure the maximum safety and health of greenhouse products. Continued education on safety principles related to food safety is suggested for agriculturists, health managers, and policy makers so as to provide safe greenhouse produce along with the implementation of health promotion measures. Further interventional studies are recommended to determine the impact of education based on PMT and other models. Interventional education studies and community-based health promotions on the basis of safety behaviors related to food safety also need to be conducted for greenhouse owners.

SIGNIFICANCE FOR PUBLIC HEALTH

To ensure the health of greenhouse products, it is necessary

to carry out educational, economic, political, organizational and supportive interventions in order to observe acceptable methods and standards in order to ensure the maximum health of greenhouse products.

AUTHORS' CONTRIBUTIONS

RF, SM and KH was involved in all aspects of study conception and design, data collection, data analysis, interpretation, drafting the manuscript and critically revising the manuscript for intellectually important content; MAMS, ZAS and MR helped in the general design of the study, data analysis, results interpretation, co-authoring and editing along the whole manuscript. All the authors have read and approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

ETHICAL APPROVAL AND CONSENT TO PARTICIPATE

The present research was approved by the ethics committee of Jiroft University of Medical Sciences, Jiroft, Iran with the ethical code: IR.JMU.REC.1394-8.

HUMAN AND ANIMAL RIGHTS

No animals were used in this research. All human research procedures followed were in accordance with the ethical standards of the committee responsible for human experimentation (institutional and national), and with the Helsinki Declaration of 1975, as revised in 2013.

CONSENT FOR PUBLICATION

The objectives of the study were explained to the volunteer Greenhouse Owners. They were ensured about confidentiality of information, and were asked to complete the informed consent.

AVAILABILITY OF DATA AND MATERIAL

The raw data and materials used to support the findings of this study are available from the corresponding author [S.D] upon request.

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None.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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