Vegetable Safety Risk Early-warning Model Based on Fault Tree

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Abstract. This paper introduced the fault tree analysis method and its application, analyses various factors of vegetable safety status and safety problems caused by vegetables, establishes the fault tree of the vegetable safety, and for this fault tree do some qualitative and quantitative analysis, combines the theory of risk analysis, and then establish vegetable safety risk early-warning model based on fault tree analysis. This model aims to predict severity of the hazards and take measures to reduce the harm may occur. In this context, this not only broadens the application domain of fault tree analysis, but also provides a reference for the safety of vegetables in the future.

Introduction

Fault tree analysis (FTA) is a kind of typical graph deductive method, is the failure event under certain conditions of logical reasoning method. It is in the process of system design, through to the system failure caused by various factors, including hardware, software, environment, human factors) is analyzed, draw the logic diagram (fault tree), and thus gradually in-depth analysis, to determine system failure reason of all possible combinations or its probability of occurrence, take appropriate corrective action, in order to improve the system reliability of a kind of design method.

Vegetable Safety Fault Tree

Based on the various factors of vegetable safety problem is analyzed, vegetable safety problems is established. As shown in Fig. 1:
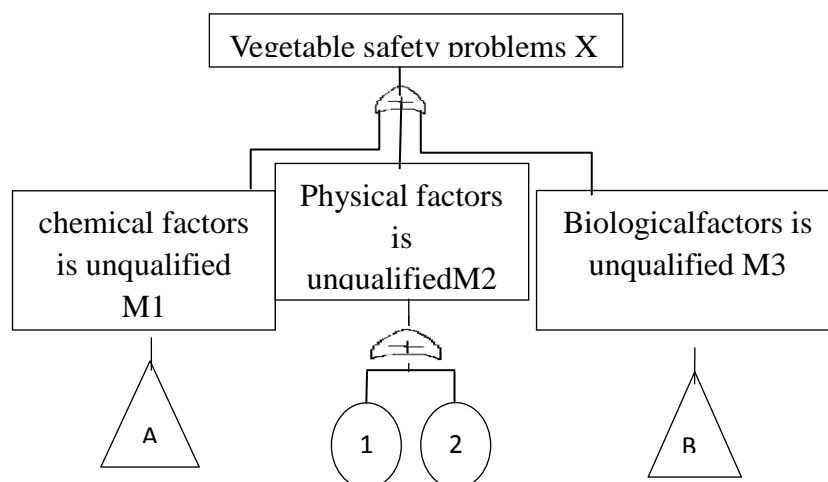

Figure 1.   Vegetable safety fault tree

Table 1   The fault tree bottom event in vegetable safety problem

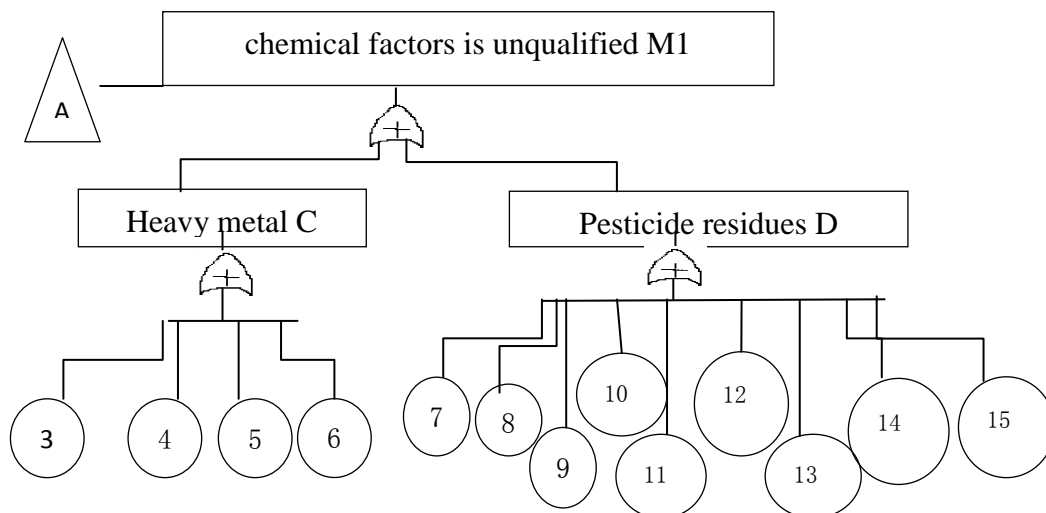| The serial number	The name of the event
1	Soft foreign body detected（Hair, insects, etc）
2	A hard foreign body detection(Sand, stones, metal wire, etc）

Figure 2.   Unqualified chemical factors in the fault tree

Because there are many different kinds of pesticides, only choose frequent pesticide residue as the bottom events. As shown in Table 2:

Table 2   Unqualified chemical factors in the fault tree bottom event

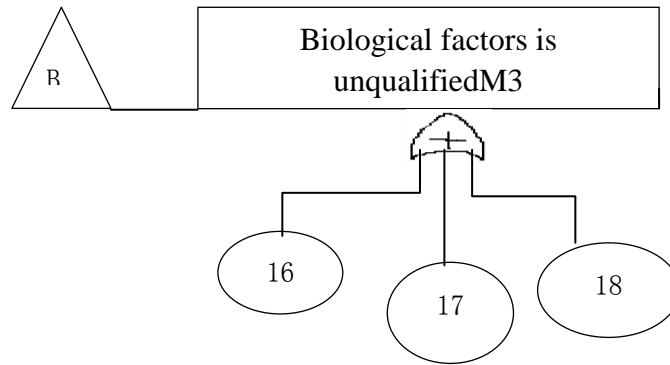| The serial number	The name of the event
3	Lead
4	Cadmium
5	Mercury
6	Arsenic
7	Omethoate
8	Mocap
9	Long acting phosphorus
10	Dichlorvos
11	Methamidophos
12	Methyl parathion
13	Acephate
14	1-Naphthalenyl methyl carbamate
15	Gram bud

Figure 3. Unqualified fault tree biological factors

Table 3 Biological factors unqualified fault tree bottom event

The serial number	The name of the event
16	E. coli and total number of E. coli
17	The parasite
18	salmonella

Vegetable Safety Fault Tree Analysis

(1) The Qualitative Analysis. Fault tree qualitative analysis is to qualitatively identify top events all possible failure modes, namely, the minimum cut sets of fault tree. Cut set is a set of basic events that guide the top events. That is to say, in the fault tree of a set of basic events, can cause the top event; this set of basic events is called cut set. A collection of some of the fault tree bottom event, when these events occur, top events occur inevitably. Minimum cut set is arbitrary cut concentration of the bottom events if remove one ceases to be cut.

For the fault tree of minimum cut set method has a downward and upward method. Descending method from top to bottom is start from the top event list replacement method step by step, While the upstream method is bottom-up using a collection of simplified operation rules, finally find out the minimum cut set from the simplified type. This article uses the ascending method for qualitative analysis.

By Figure 3-2, Figure 3-3 and Figure 3-4 ,

M3=16+17+18, C=3+4+5+6, D=7+8+9+10+11+12+13+14+15,

Upgrade level calculated:M1=C+D, M2=1+2,

The top event is obtained:

X=M1+M2+M3=1+2+3+4+5+6+7+8+9+10+11+12+13+14+15+16+17+18。

Conclusion: the minimum cut set of the fault tree are {1}, {2}, {3}, {4}, {5}, {6}, {7}, {8}, {9}, {10}, {11}, {12}, {13}, {14}, {15}, {16}, {17}, {18}, {19}。

(2) Quantitative Analysis. Quantitative analysis of fault tree there are two major aspects: First, the failure probability of the system is calculated, second, The structure, key and probability importance of each base event are calculated.

First, the failure probability of the system is calculated: we assume that the system exists n minimum cut sets, respectively, E1, E2, E3, EN. Then the system failure probability of top event X is :P（X）=P(E1∪E2∪…∪En)=P(E1+E1′E2+E1′E2′E3+…E1′E2′…En-1′En)[13]。

Then, in the general case, quantitative analysis of fault tree, we only need to calculate the system failure probability, And in this paper, the structure, the probability of the basic events and key importance no application, in this not do a detailed analysis.

Level of Risk Evaluation

Degree of risk = hazard occurrence possibility L* hazard consequences severity S. The division of risk grade of vegetables and the countermeasures of different risk grades are listed in Table 4:

Table 4　Risk grade classification

Risk degree	Grade	Behavior control measures should be taken.
20-25	Huge risk	Immediately take measures to reduce the hazards, identify the key reasons, and focus on the control of.
15-16	Major risk	Take emergency measures to reduce risk, establish operational control procedures, regular inspection, measurement and evaluation.
9-12	secondary	Strengthen supervision and control, always pay attention to the trend of risk change, and strive to low risk.
4-8	Can be tolerated	Can consider the establishment of production, circulation and storage specifications, to maintain the existing level, no conversion to the high level of risk.
<4	Slight or negligible	Control measures are not required, but record keeping is required.

The probability of occurrence of the hazard and the probability of the top event of the fault tree is shown in Table 5, Table 6.

Table 5　The possibility of hazard occurrence L division

Probability(P)	<0.1	0.1～0.25	0.25～0.5	0.5～0.75	0.75～1
Likelihood (L)	1	2	3	4	5

Control Measures Taken

Table 4 shows, for the medium risk, we should strengthen the supervision and control, focus on the risk change trend, and strive to low risk. Put forward specific control measures: for dealer, it should strengthen the source of the monitoring of vegetables, the sale of high-quality vegetables; For producers, it should be strictly in accordance with the requirements of the use of chemical fertilizers and pesticides, do not use highly toxic and even banned pesticides, do not use contaminated water for irrigation, and need to know about the soil of growing vegetables, not to grow vegetables in contaminated soil; for consumers, should improve their awareness of the safety of vegetables, do not blindly listen to a variety of media and advertising, have their own judgment, get the knowledge of vegetable safety through multi channels.

Table 6   Serious harmful consequences of S division

Grade	Feeling and reaction after human consumption	Chemical hazard	Physical hazard	Biological hazard	The cognition of vegetable safety	The spread of knowledge about the safety of vegetables
5	Poisoning is strong, and even death.	Have a lot of heavy metals and pesticide residue detection	There are non natural hard objects, such as: metal wire, etc.	Detection of a variety of pathogenic bacteria, and excessive	Very low	Knowledge or point of view is wrong, misleading people
4	Toxic reactions can be alleviated by treatment	Heavy metals and pesticide residues were detected in 1-2	There is a natural hard body, such as: soil	Detection of a pathogenic bacteria, and excessive	Relatively low	There is no scientific basis, so that people develop false consciousness
3	No toxic reaction, but the feeling is not suitable	Heavy metal or pesticide residues were detected 1-2, and exceeded	Have a soft non-natural foreign body, such as: hair	Two pathogenic bacteria were detected, but not exceeding the standard.	low	Don't get close to the life, not essential
2	Taste in general, adverse effects on the body	Heavy metal or pesticide residues were detected, but not exceeding	There are soft natural foreign bodies, such as insects	Detection of a pathogenic bacteria, but not excessive	Relatively high	Life common sense propaganda, the effect is not big
1	Good taste, good for health	Heavy metals and pesticide residues were not detected	No foreign body	No pathogenic bacteria	high	Conduct propaganda to promote the formation of vegetable safety awareness

To Establish a Vegetable Safety Risk Early Warning Model

Based on the vegetable safety fault tree and risk analysis, the warning model is established in Fig. 4:
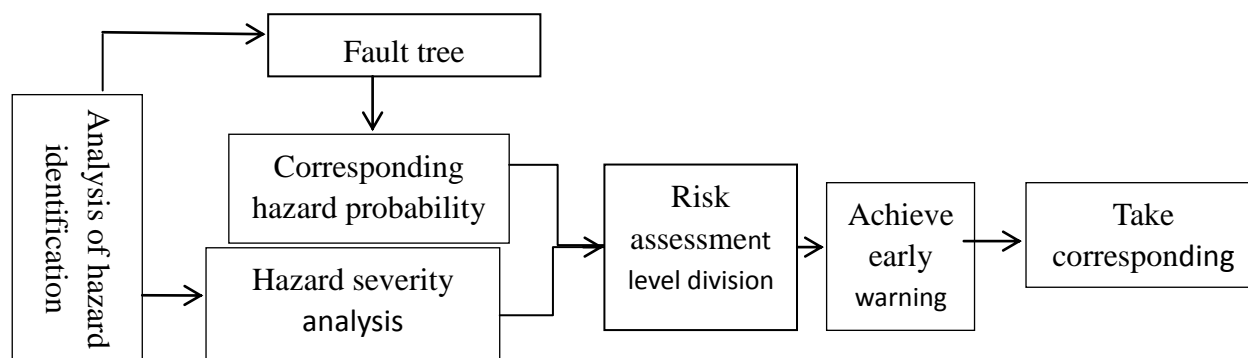
Figure 4.   Early warning model of vegetable safety risk

Acknowledgment

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