

## **Food Security Practices: A Self-Evaluating Checklist to Assess the Food Security Concept in Food Preparation Facilities**

**Hettiarachchi AM\***

*University of Moratuwa, Sri Lanka*

**\*Corresponding Author:** Hettiarachchi AM, University of Moratuwa, Sri Lanka.

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### **Abstract**

Food Security introduced four pillars of food security namely; availability, access, utilization, and stability. However, the scope of food security is insufficiently addressed by the ISO 22000:2005 food safety standards. The purpose of this study is to develop an extended framework of standards opposed to ISO 22000:2005 food safety standards considering one additional pillar in food security, which is food safety, with a special reference to edible oil and oil-based products in Sri Lanka. Among 745 Colombo Municipal Council (CMC) registered food preparation facilities, 75 facilities were selected as a stratified random sample. A self-administered online questionnaire was used to identify gaps in local food security practices in edible oil. Data analysis was performed using SPSS version 21 and characteristics of sample were analyzed using descriptive statistics. The results of the survey revealed that the Sri Lankan food preparation facilities are significantly behind in food security practices. Considering the deviated areas in the practice, which were identified through our questionnaire, a checklist was developed by giving more attention to above mentioned deviated areas.

**Keywords:** *Cooking Edible Oil; Fats and Oils; Food Preservation and Safety; Risk Assessment*

### **Introduction**

The concept of food security has been emerged in the 20<sup>th</sup> century and many multilateral organizations such as World Bank, International Monetary Fund, World Trade Organization and United Nations (UN) have utilized the term “food security” to describe the global effort to eliminate hunger and malnutrition [1,2]. Food safety and food security are interrelated concepts with a profound impact on quality of human life. In 2009, the World Summit on Food Security introduced four pillars of food security namely; availability, access, utilization, and stability. Food security could be substantially improved by increased investment and policy reforms [3-6].

Food safety is an umbrella term that encompasses many facets of handling, preparation and storage of food to prevent food borne illness and injury. Included under the umbrella are chemical, microphysical and microbiological aspects of food safety. Food borne illnesses show an increasing trend, but still many go unreported and public awareness on food safety and risk management procedures is at a low level in the domestic market [7]. There is a growing concern about food safety issues in Sri Lanka with the expansion of the food industry along with urbanisation, increased trade in fresh and processed food, and more consumption of foods of animal origin. Establishing food hazard analysis critical control point systems along with an effective national food control system, imposing a Sri Lankan standard for processed food, amending Food Act no. 26 of 1980, harmonisation of food regulations with other countries, and conducting public awareness programmes on food safety issues, would be productive measures in managing food safety risk. Still there are many areas needing improvement.

According to the literature review many studies document commonly accepted theory at present is that the consumption of poly-unsaturated oil is healthy but it is not the case always. The reason is that European countries do use a lot of poly-unsaturated oil but, they rely on very light cooking at relatively lower temperatures. Because low temperatures are generally better for retaining the highest nutrient content of food and for reducing oxidation and its associated toxic by-products. However, we do heavy cooking at high temperatures and unsaturated /poly-unsaturated oil is thermally very unstable and form Trans -fatty acids/ peroxides which are not good for human health [8]. Therefore, development of unhealthy, carcinogenic chemicals because heating higher temperature. The international and national literature regarding local food policy and food security strategies highlight some common themes.

Food security policies and programmes have the potential to play a role in reducing acute health care costs through preventative measures, support economic development and create jobs by developing local agro-food industries, raise the quality of life of residents by increasing access to safe, nutritious food, and promote environmental wellbeing through sustainable agriculture techniques or the promotion of local food [9].

The section regarding working with the food industry highlights the multiple levels of the food supply chain. The World Health Organization also recommended that working with the food industry should involve acting in all areas of the food supply chain. The food supply chain can be broadly divided into three areas: upstream -primary food production; midstream - food manufacture; and downstream, which is the food retailers. The report highlights the role of public health and local government to work with the food sector to investigate interventions that make nutritious food more affordable, noting that collaboration is often difficult due to the fundamental differences in the goals of public health and the food industry [10]. Improving food safety is an essential element of improving food security and it combines food safety and food security into the concept of “safe food consumption.” Therefore, food safety must be an enabler and not inhibitor of global food security [11,12].

The ISO 22000:2005 family of international standards is one of leading food safety security management systems and it specifically addresses food safety management. However, the scope of food security is insufficiently addressed by the ISO 22000:2005 food safety standards [4, 5,15].

### Purpose of the Study

The purpose of this study is to develop checklist for self-evaluation of Food Security Management System food preparation facilities considering one additional pillar in food security, which is food safety, with a special reference to edible oil and oil based products in Sri Lanka [16-19].

### Methodology

With regard to the research framework presented, there are five main constructs to operationalize: availability, access, utilization, stability and safety. However, these indicator statements were modified where ever necessary applicable to local food preparation facilities. We used a self-administered online questionnaire to assess the knowledge and practice of food security concept under the indicators of procurement, distribution and exchange, affordability, allocation, utilization and safety. Responses to each indicator were used to identify gaps in local food security practices in edible oil. The basis for selecting each question under each indicators based on the literature survey; procurement based on Bouchon, Pedro (2009). “Chapter 5 - Understanding Oil Absorption During Deep-Fat Frying”. *Advances in Food and Nutrition Research*. 57: 219., distribution and exchange based on Kochhar, Parkash, Henry, Jeya (2009-01-01). “Oxidative stability and shelf-life evaluation of selected culinary oils”. *International Journal of Food Sciences and Nutrition*. 60 Suppl 7: 289-296., [http://www.searo.who.int/entity/world\\_health\\_day/2015/whd-what-you-should-know/en/](http://www.searo.who.int/entity/world_health_day/2015/whd-what-you-should-know/en/) and Ecker and Breisinger (2012). *The Food Security System*. Washington, International Food Policy Research Institute. pp. 1–14., affordability based on Gregory, Ingram, Brklacich (29 November 2005). “Climate change and food security”. *Philosophical Transaction of the Royal Society B: Biological Sciences*. 360 (1463):

2139-2148. Frank, ed. (2011).Vegetable Oils in Food Technology (Second ed.), allocation based on Frank, ed. (2011).Vegetable Oils in Food Technology (Second ed.) and Wai, Masahiro, (1-3 August 2014) Street foods safety in Yangon: A case study on street food vendors' socio-economics and production aspects, Proceedings of the First Asia-Pacific Conference on Global Business, Economics, Finance and Social Sciences (AP14Singapore Conference), Paper ID: S458, utilization based on Bouchon, Pedro (2009). "Chapter 5 - Understanding Oil Absorption During Deep-Fat Frying". Advances in Food and Nutrition Research. 57: 219., Ravnskov, (June 1998) The Questionable Role of Saturated and Polyunsaturated Fatty Acids in Cardiovascular Disease, Journal of Clinical Epidemiology, Volume 51, Issue 6, Pages 443-460. Frank, John, Albert, eds. (2007).The Lipid Handbook (Third ed.), stability based on Boskou, Dimitrios (2010). "21 Frying Fats". Chemical and functional properties of food lipids. p. 429., and safety based on ISO 22000 food safety management system – Requirements for any organization in the food chain, (First edition 2005- 09- 01).

Each indicator statements were measured on 0 – 5 Likert scale; Strongly Agree (5), Agree (4), neither Agree nor Disagree (3), Disagree (2) or Strongly Disagree (1), not sure (0).

### The indicator statements relevant to each concept variables are listed as follows

#### Procurement

1. Purchasing requirement is an important pre-requisite to be taken by the company.
2. Brand of the required oil is considered as an important fact when purchasing by the company.
3. Quality of the purchasing product is a mandatory requirement.
4. Purchasing company is a system certified one.
5. Cost of the product is the most important fact consider during purchasing.
6. Next purchasing order before reaching the threshold volume of the buffer stock of the product.

#### Distribution and exchange

1. The vehicle condition during transportation of purchased oil.
2. The packing material of the oil during transportation.
3. Cooking oil receiving packing materials are according to the requirement is important.
4. Internal material distribution system in order to fulfil the requirement.
5. The storing temperature, during the storage of the cooking oil.
6. Internal material distribution system to supply the most suitable oil for the relevant cooking method.
7. Material distribution system as it is important for food security.
8. Traceability system to ensure the safety of the product.

#### Affordability

1. Even in a higher price, company is capable of purchasing the exact required quality edible oil to fulfil the demand without any shortage.
2. Quality of the product is the key factor to decide about the purchasing particular branded product.
3. Price of the product and brand name are considered as important factors to consider in purchasing.

#### Allocation

1. Most of the time procurement management system is capable in providing the requirement continuously.
2. A single oil type is adequate for all cooking purposes.

3. Due to cost effectiveness, choice of oil should be restricted to one or few brands.
4. As there are no wide variety of food types it is acceptable to use a single brand/type of oil.

### Utilization

1. Deep fat frying is commonly used due to the tasty of the food and increased demand from customers.
2. Deep fat frying is commonly used due to the shelf life stability of the fried food.
3. The fact that Not all types of edible oil are suitable for deep fat frying.
4. The fact that oil absorption to food is high during deep fat frying.
5. The fact that Oil absorption to food is increased with increasing the frying time.
6. The fact that Oil absorption to food is decreased by adding some natural ingredients, Coating and batters.
7. The fact that Oil absorption to food mostly occurs during post frying cooling.
8. The fact that High pressure vacuum fryers increase oil absorption to food.
9. The fact that Low pressure fryers maintain the colour and nutrient contents of the food, quality of the cooking oil and thus reduces toxic generation.
10. Following criteria to select frying oil.
  - a. Long frying stability of the cooking oil.
  - b. Low tendency to foam or form smoke.
  - c. Low tendency to gum.
  - d. Price of the oil.
11. Cooking in high temperature can affect to the quality of the oil.
12. Repeated usage of used cooking oil can be resulted in unhealthy food.
13. Uncleansed utensils used for the cooking purpose can affect the cooked product's nutritional value.
14. Monitoring the water quality is a mandatory requirement.

### Stability

- Usually we encounter shortage of cooking oil.
- Maintain the minimum required quantity for the cooking oil.
- Equipment for controlling and monitoring the temperate in cooking.
- Calibrate all the monitoring equipment and keep monitoring records.
- Preventive maintenance according to the plan.

### Safety

1. Personal hygiene including hand washing before and after handling the cooking oil.
2. Health check-ups and health certificate for food handlers.
3. Pest controlling methods can affect the cooking product safety.
4. Wear personal protective equipment during food handling.
5. Identify the critical points such as cooking temperature, pH level when designing the menu.

6. Food safety team or company workers have a knowledge about food security in relation to the product utilization and nutritional value.
7. Food safety team or company workers have knowledge about food security in relation to the product health status of the individuals consuming the food.
8. Food safety team or company workers have knowledge about food security in relation to the product principle of post-harvest, food preservation and quality control.

These statements were converted to questions in the questionnaire. In addition to the main questions, a set of general questions about category of food preparation facility, current certified standard, and usage of cooking oil were also included to the questionnaire.

During the research limitations for: only food processing facilities registered under Colombo Municipal Council were recruited for the study. Further, only the food security concept and hazards developing during the cooking process were considered for the study.

There were 745 Colombo Municipal Council (CMC) registered food preparation facilities and 75 (10% of the total population) food preparation facilities were randomly selected. This 75-sample size consists in following way; total population of hotel was 77 and selected sample size was 08, total population of eating house was 538 and selected sample size was 54, total population of restaurants was 108 and selected sample size was 11, total population of guest houses was 22 and selected sample size was 2. The list of food preparation outlets was traced from CMC and were randomly selected according to the alphabetical order.

Descriptive and inferential statistics were used to measure the variables and assess the conceptual model. Parametric tests as well as nonparametric tests were used to in the analysis. Data were entered and analyzed by using the Statistical Package for Social Sciences (SPSS 21).

### Data analysis

During the data analysis, as demographic factors: profession, working experience at the current profession, categories of facility, system standards being certified the facility, types of cooking oil mostly used, reason for the selection of mostly used cooking oil, different modalities of cooking oil usage and awareness about food safety management system were considered (Table 1).

Of the total responders, 60% were chefs and 40% were hotel managers. Out of total responses, 59.1% had awareness about the food safety management system for 2-5 years. Around 28.2% of participants were aware about this concept for more than 6 years. Majority of the participants i.e. 54.6% used Palm oil as the cooking oil, and 28% Soybean oil, 10.7% Sunflower oil and least number of participants i.e. 6.7% utilized Coconut oil as a dripping. Despite of awareness, as a practice, 37.3% selected the cooking oil as a routine, 34.7% selected considering cheap in price, 12% considered popularity in the market and 10.7% considered its easy availability. Only 5.3% of participants actually considered the healthy and nutritional values of oil when selecting the type of cooking oil for their routine use. Further, majority of the participants i.e. 52%, used palm oil for frying purpose despite of the awareness on adverse health consequences from frying with palm oil.

The validity and consistency of measures is very important to evaluate the credibility of the items in order to move ahead with the rest of the analysis. The adequacy of the measures was calculated by using Kaiser-Meyer-Olkin (KMO). KMO values between 0.5 and 1 indicate the sampling is adequate. KMO values less than 0.5 indicates the sampling is not adequate (Table 2).

Bartlett's test of Sphericity tests the null hypothesis that the correlation matrix is an identity matrix, which indicates that variables are unrelated and thus unsuitable for structure detection. Values less than 0.05 of the significance level indicate that factor analysis is useful with our data (Table 2).

No.	Demographic factories	Percentage (%)	Number of responses
01	Profession:		
	a) Chef:	60.0	45
	b) Manager:	40.0	30
02	Working experience at the current profession:		
	a) <2 years:	8.0	06
	b) 2-5 years:	36.0	27
	c) 6-10 years:	38.7	29
	d) 11 – 15 years:	8.0	06
	e) >16 years:	9.3	07
03	Awareness about the food safety management system:		
	a) <2 years:	12.7	09
	b) 2-5 years:	59.1	42
	c) 6-10 years:	18.3	13
	d) >11 years:	9.9	07
04	Categories of facility registered:		
	a) Eating house:	73.3	55
	b) Guest house:	2.7	2
	c) Hotel:	10.7	8
	d) Restaurants:	13.3	10
05	System standards being certified the facility:		
	a) GMP:	30.0	3
	b) HACCP:	20.0	2
	c) ISO 22000:2005:	50.0	5
06	Types of cooking oil mostly used in the facility for the cooking purpose.		
	a) Palm oil:	54.6	41
	b) Soybean oil:	28.0	21
	c) Sunflower oil:	10.7	08
	d) Coconut oil:	6.7	05
07	Reason for the selection of mostly used cooking oil:		
	a) easily available:	10.7	08
	b) cheap in price:	34.7	26
	c) healthier than other oil:	5.3	04
	d) as a routine:	37.3	28
	e) popular in the market:	12.0	09
08	Different modalities of cooking oil usage:		
	a) Cooking:	48.0	36
	b) Frying:	30.7	23
	c) Stir frying:	1.3	01
	d) Deep frying:	20.0	15

**Table 1:** List of demographic factories.

Variable	KMO	Bartlett's test of Sphericity	Number of indicators
Procurement	0.565	0.00	6
Distribution and Exchange	0.844	0.00	8
Affordability	0.551	0.00	3
Allocation	0.601	0.00	4
Utilization	0.693	0.00	14
Stability	0.625	0.00	5
Safety	0.572	0.00	8

**Table 2:** KMO and Bartlett's test of sphericity.

KMO value in variable procurement, affordability and safety were less than 0.6, allocation, utilization and stability were less than 0.7 and distribution and exchange more the 0.8 (Table 2).

Therefore, distribution and exchange variable samples were adequate. Procurement, affordability and safety variable samples were not adequate.

However, all the variables Bartlett's test of Sphericity was less than 0.05 of the significance level indicate that factor analysis was useful with our data.

Significance of the relationship between deviated variables found during the analysis was compared with three domains i.e. system certified and non-certified food preparation facilities, working experience less than or equal five years and more than or equal five years, duration of awareness about the food safety management system less than or equal five years and more than or equal five years. System certified food preparation facility: according to the sample of population out of 75 food preparation facilities 10 food preparation facilities were system certified for ISO 22000:2005, HACCP and GMP.

Comparisons between system certified and non-certified food preparation facilities: Mann-Whitney test was used to assess the significance between variables and the significance value was taken as  $P < 0.05$ .

One sample t- Test was used to determine the statistically significant difference exist between respond of the sample used in the study and the mean of the standard respond. Here we assessed all practices in all dimensions proposed in the framework for an average value of 3. Value 3 represents an indifferent practice or awareness. If the average was not significantly equal to 3, then we assessed the nature of the differences.

**Discussion**

As a percentage, 30% of food preparation facilities had GMP certification, 20% had HACCP and 50% of certified outlets has certified with ISO 22000. Of the total, 68% of responders were aware about the food safety management system for more than 5 years. The duration of awareness of food safety management system was significantly associated with the consideration of system certification of the purchasing company, consideration of packing materials during transportation and consideration of critical points like pH, temperature when designing a menu. Although there was no significant association, responders who were having long term awareness about the food safety management system, have considered to purchase required quality product even in higher price. But the mean value for maintenance of the buffer stock was higher in the group who have less than five years of experience in food safety management system [21,22].



About 56% of responders were having more than 5 years of working experience and 44% of responders were having less than 5 years. Working experience of the responders was significantly associated with the consideration of system certification of the purchasing company and consideration of critical points like pH, temperature when designing a menu ( $p < 0.05$ ). Although there was no significant association, responders who were having long term working experience, considered the quality of the required product when purchasing even in higher market price [23,24].

The relationship between the concern about the packing material of the oil during transportation and using deep fat frying in order to increase the shelf-life stability with the certification of the food preparation facility were found to be more than 0.05 and therefore accepting null hypothesis. This implies that both certified and non-certified companies did not concern about above two facts. But consideration of system certification of the purchasing company, maintain a buffer stock, consideration of vehicle condition during the transportation, storing temperature of cooking oil, ability to purchase required quality product even in higher price, using equipment to monitor and control the temperature during the cooking, calibration of all the monitoring equipment and consideration of critical points like pH, temperature when designing a menu were significantly higher in certified food preparation outlets ( $p < 0.05$ ). The mean value for consideration of packing material during the transportation was more than 3 in certified food preparation outlets. This implies that although there was no significant association, certified outlets consider the above facts compare to non-certified outlets.

In our study population, majority of the participants were aware of safety measures recommended in the ISO 22000:2005 food safety standard. But the concern on impact of physical parameters on nutritional status when preparing a menu, was significantly poor among participant food outlets. It is known that cooking induces significant changes in chemical composition, influencing the concentration and bioavailability of bioactive compounds specially in vegetables. But this fact was not evaluated in the current safety standard and most of the study population did not have a clear image about importance of considering the impact of cooking conditions on nutritional value of processed food when preparing food items.

Purchasing higher quality ingredients is a paramount important step in delivering quality nutritious food to the consumer [25-27]. Quality, brand reputation and the cost of the purchasing product were considered as most important pre-requisites when selecting a supplier by our study population. But system certification of the supplier was not considered as a required fact during supplier selection. Product certification verifies that a food product complies with the safety and are according to the standard specifications [28-32]. This will not only give a competitive advantage in the marketplace but provide assurance of the product quality. But food outlets of the current study neglect the supplier's quality standards. Further, when we elaborating the number of certified companies in our study population, it was 13% of the total and this implies that most of the small-scale food outlets have poor understanding about the importance of system standards. Despite of launching new food regulatory concepts, reasons for not giving much attention for regulatory standards should be evaluated. This could be due to lack of their knowledge or purposeful negligence. This can be strengthened by developing a well-prepared food security system in addition to the current safety standard [33].

### Conclusion

The results of the survey revealed that the Sri Lankan food preparation facilities are significantly behind in food security practices because they more focus on food safety management principles. Therefore, we suggest to include four pillars in food security systems into the food safety management system standard, as food security practices are significantly deficient in our existing system.

Thus, we prepared a checklist considering availability, access, utilization, stability and safety indicators and use those indicators according to the "4 M"- man, method, materials and machine. Thus checklist can be used to assess how food security four pillars and safety indicators can be utilized during the procurement, storing and distribute materials, preparation for process, processing, storing and distribute processed product and general requirement (Figure 1).





**Figure 1:** Conceptual checklist framework.

Therefore, our recommended checklist can be used to identify the deviations in the existing practice and the areas need to be further improved, thus giving a comprehensive assessment of food preparation facilities.

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