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Challenges in cleaning for frozen food SMEs: Current and suggested cleaning program

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Abstract
Cleaning can be costly and complex especially for SMEs. Food SMEs have a restricted budget and knowledge to implement an effective cleaning program. A study was conducted in a frozen food SME to investigate the current cleaning practice. Physically and microbiologically cleanliness was set as the cleaning target. Results show that the current cleaning program was unable to reach a physically clean condition. A new cleaning program was suggested for this frozen food industry. The new cleaning program was expected to help this factory to reach physically and microbiologically clean conditions. A clean environment can lead to better food product quality and appearances.

Keywords: Cleaning, cleaning program, fouling mitigation, frozen food industry

Introduction

An effective cleaning program is essential for every food factory. Many food manufacturer SMEs do not have adequate knowledge to design their own cleaning program (Noor Hasnan et al., 2014; Khalid et al., 2016; Köhler et al., 2015). Thus they tend to follow the cleaning program implemented by bigger and successful food factories. The cleaning program might not suitable as it is designed for bigger or different types of food production.

Cleaning process includes 1) removal of gross debris 2) pre-rinse, 3) detergent wash (usually alkaline wash), 4)intermediate rinse, 5) second detergent wash (usually acidic wash: optional) 6) intermediate rinse, 7) disinfection, 8) final rinse (optional) (Tamime, 2008). Each cleaning steps has different functionality with different cleaning parameters (temperature, fluid velocity, chemical concentration) are manipulated to generate an effective cleaning program (Tamime 2008; Etienne, 2006; Khalid et al., 2014, 2015, 2016).

However, food manufacturer SMEs tend to skip some of the cleaning steps which can be costly, for instance cleaning or rinsing with hot water. Hot water cleaning step can increase the cleaning performance and effectively reduced food borne pathogens to an acceptable level. In removing the invisible fat layer which is common in meat patty production, hot water rinsing is necessary. Moreover, hot water rinsing can replace disinfection detergent that is costly. Nevertheless, the boiler is essential for this process. SMEs try to avoid boiler utilization as it will increase the operating and maintenance cost.

Physical, chemical and microbiological cleanliness are most common cleanliness level associated in the development of a cleaning program (Khalid et al., 2014; Khalid et al., 2015; Khalid et al., 2016; Tamime, 2008). The food processing surfaces (equipment, floor and wall) are physically clean when all visible 'soil' or residues are removed by the cleaning operations. Surfaces are microbiologically clean when numbers and types of microorganisms are reduced to an acceptable level. Chemically clean condition when materials used in plant cleaning and/or sanitizing are removed completely. In this work, only indirect microbiological cleanliness is used as the cleaning target.

The objectives of this paper are to identify current cleaning practice and to redesign an efficient cleaning program for the frozen food industry.

Materials and methods

Identifying the current cleaning program

A frozen meat patty factory (factory X) at Sungai Chua, Selangor, Malaysia was used for the case study. The factory is a small andmedium (SME) factory with average capacity production 1000 kg to 1500 kg patty per day. This factory operated for 8 hours daily. Figure 1 shows the manufacturing process of a meat patty at factory X. Every process is a batch processing. The function of each equipment is also shown in Figure 1.

The current cleaning practice was expected not efficient due to cleaning was performed with tap water at room temperature, domestic tap water pressure, inappropriate cleaning tools and without a well-designed cleaning program.

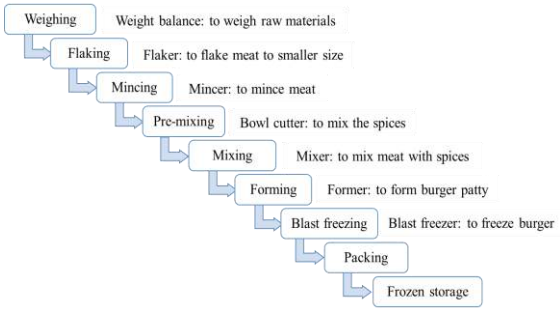

Figure 1. The manufacturing process of meat patty

Cleaning validation

The indirect microbiological cleanliness of the food processing equipment (flaker, mincer, bowl cutter, weigh balance, mixer and burger former) and areas (floors and walls) were tested using Path-Check Hygiene Protein (Microgen, United Kingdom). Path-Check Hygiene Protein was used to detect the presence of protein residue on food contact surfaces. The swab cotton colour will change from yellow to green when there was protein residue on the surfaces. This indicates the surface was not microbiologically cleaned. The presence of protein indicated the potential of microbe's growth. The physically clean condition was determined based on visual and touch inspection.

3 different areas were swabbed for each equipment and factory areas (walls and floor). For equipment, 3 areas which are difficult to clean such as blades and edge were swabbed. While for the wall and floor area which were near to the flaker and burger former were chosen as our study area as the area were the dirtiest area as during processing the meat splashed from the equipment.

If only one of the area was not cleaned, the equipment was considered not clean. Observation and protein swab test was performed for 3 days to get average data.

Designing a cleaning program

A new cleaning program was designed to clean different food processing equipment and areas. This new program incorporate a new cleaning apparatus such as industrial cleaning brushes (Hillbrush, United Kingdom) (Figure 2) and a portable cleaning unit. The portable cleaning unit produces the desired hot water without the need to assemble a boiler inside the factory area. The portable cleaning unit has two main parts; (1) storage tank, and (2) spray nozzle. This portable cleaning unit was designed and constructed at the Process and Food Engineering laboratory of the Faculty of Engineering, the Universiti Putra Malaysia, Malaysia. This cleaning unit has a stainless steel tank (100 L) containing a heating element which was used to store and heat the cleaning solution. The spray nozzle (even flat spray VNP series, 30° spray angle, spray capacity code 49, H. Ikeuchi & Co., Ltd., Japan) was used to generate high pressure fluid for cleaning. This cleaning unit can be operated at nozzle pressure varying from 5.2 bar to 7.0 bar and capable of withstanding contact with detergents and disinfectants at the cleaning temperatures (20 °C to 110 °C).

Results and discussion

Current cleaning program

The comparison between the current cleaning program and suggested the cleaning program is shown in Figure 3. The current cleaning program is shown in Figure 3(a). Cleaning equipment Part 1 was started after the mixing process (Figure 1) which mixer, flaker, mincer, weigh balance and bowl cutter were cleaned (Figure 3 (a)). During equipment cleaning, workers used water buckets, common pipe hoses and common brushes. The water pressure from the pipe hose cannot be controlled and limited. Thus, it is not enough to remove meat residues. As an alternative to adding mechanical action, they used water buckets during rinsing. However, the meat residues splashed all over surrounding areas including wall, floor and equipment near the cleaned equipment. Cleaning detergent was applied on the equipment surfaces and was brushed using common brushes. Then, the equipment was rinsed again with water.

Next, the walls near this equipment were cleaned. Workers used a water bucket to remove the meat residues attached on the walls. Then, they applied cleaning detergents and used a common sponge to brush the wall surfaces. From observation and interviews with the workers, it is difficult to clean areas such as edge and blades. There were hand injuries were reported due to the cleaning of sharp blades of mixer and mincer. Workers also suffer back pain as they have to bend to clean the mixer with a deep tank and to carry heavy water bucket.

After brushing with detergent, they rinsed the wall with a water bucket and pipe hose. Then, they cleaned the floor used a common floor broom to gather the meat residues and to swipe the remained water. At the same time, the burger former was operated to form the meat patty to the desired form. As the forming process ended, the former was cleaned. Then followed by cleaning at the wall and floor near the former respectively.

The cleaning effectiveness for the current cleaning program was validated using the protein swab test and the result is shown in Table 1. Visual and touch inspection were also performed to ensure physical cleanliness. The result shows that none of the equipment and areas were cleaned properly. There were still remaining meat residues remained on the surfaces. Moreover, there was still an invisible fat layer remained on the surfaces. The invisible fat layer act as a protective layer which prevents the microbes and other food compositions (ie. protein, carbohydrate) removal. Thus, it can be concluded that the current cleaning program was not sufficient enough and a new improved cleaning program is needed.

The suggested overall cleaning program

A new cleaning program with an additional cleaning apparatus (a portable cleaning unit and industrial cleaning brushes) was suggested for this factory. Suggested cleaning program is shown in Figure 3 (b). The cleaning sequence is different from the current cleaning program (Figure 3 (a)). After production, it is suggested to clean the wall first and then followed by equipment cleaning. Then eventually ended with floor cleaning. The purpose of this new sequence is to avoid cross contamination due to the splashing of

meat residues when cleaning the walls. The portable cleaning unit is expected to replace the usage of common pipe hose and water bucket. The cleaning unit can generated water at the desired fluid velocity and temperature. It is important to know the suitable fluid velocity and temperature.

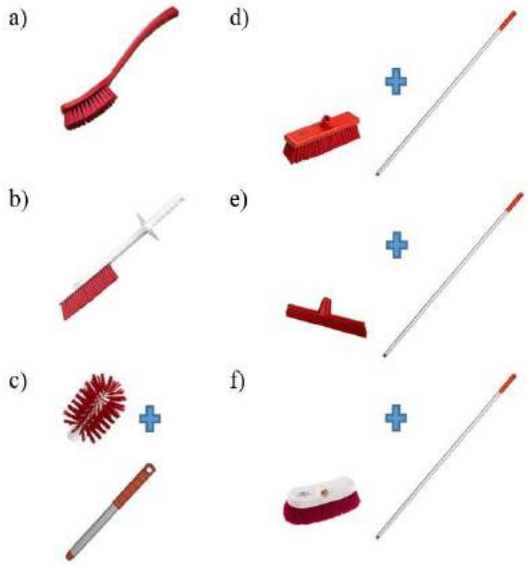

Figure 2. Industrial cleaning brushes: a) long handle brush, b) guarded machine brush, c) plastic core tube brush (with handle), d) flat sweeping broom (with handle), e) single Blade Ultra Hygienic Squeegee (with handle) and f) Soft Curved Wall Brush (with handle).

Suggested cleaning program: wall

A standardized cleaning method for wall cleaning is necessary to maintain the cleanliness of the walls (Etienne, 2006). The suggested method for wall cleaning is shown in Figure 4. First, the wall was rinsed with high pressure water generated using the portable cleaning unit. The industrial cleaning brushes were soaked in cleaning detergent at ±49°C. Then, the wall is brushed and the cleaning detergent was left stand for 5 minutes before water rinsing. Appropriate industrial cleaning brushes are also important as they can assist in easier cleaning for workers and also produce good cleaning performance. Figure 2 (f) shows a soft curved wall brush which is used to clean wall. Since it is curved, it is easier for workers to clean the walls.

Table 1: Level of cleanliness for each food processing equipment and area

Equipment	Level of cleanliness		
	Visual inspection	Touch inspection	Protein swab test
Weigh balance	****	×	NC
Flaker	***	×	NC
Mincer	***	×	NC
Bowl cutter	****	✓	NC
Mixer	****	×	NC
Burger former	**	×	NC
Wall (near flaker)	****	×	NC
Wall (near former)	***	×	NC
Floor (near flaker)	****	×	NC
Floor (near former)	***	×	NC

(Notes: ****** Highest physically clean, * Lowest physically clean, ✓ Physically clean from fat-based fouling deposit, × Fat-based fouling deposit remained, NC- not clean (protein residue detected), C- clean)

Suggested cleaning program: floor

The standard cleaning program for the floor was adapted from Etienne (2006) as shown in Figure 5. Hot and high pressure water jet was used to gather the meat residues to the drain or at the collector grates. The meat residues were collected. Then cleaning chemical was spread evenly on the floor and left stand for 5 minutes. Then, flat sweeping broom (Figure 2 (d)) was used to brush the floor. Water rinsing was performed and single blade ultra-hygienic squeegee (Figure 2 (e)) was used to remove the water residues from the floor. It is important to let the floor dry to avoid any microbial growth.

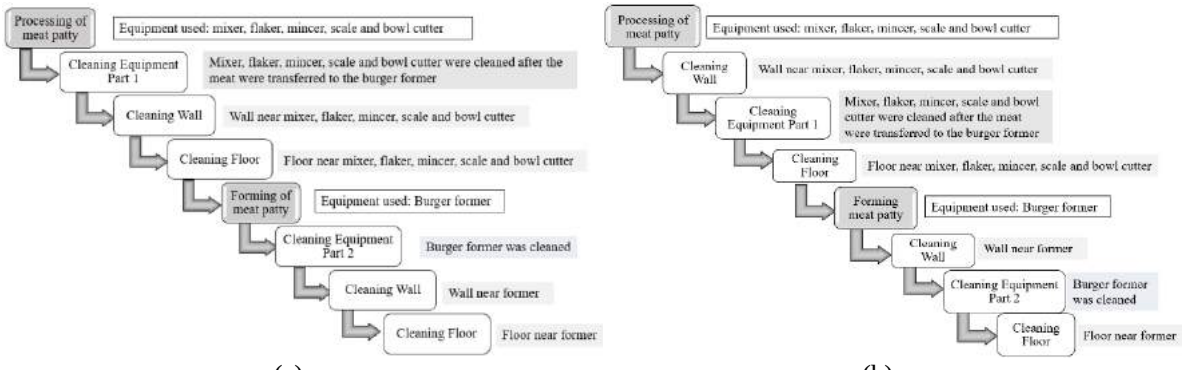

Figure 3. (a) Current cleaning program and (b) suggested cleaning program

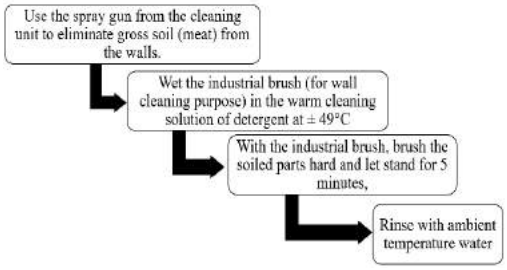

Figure 4. Wall cleaning

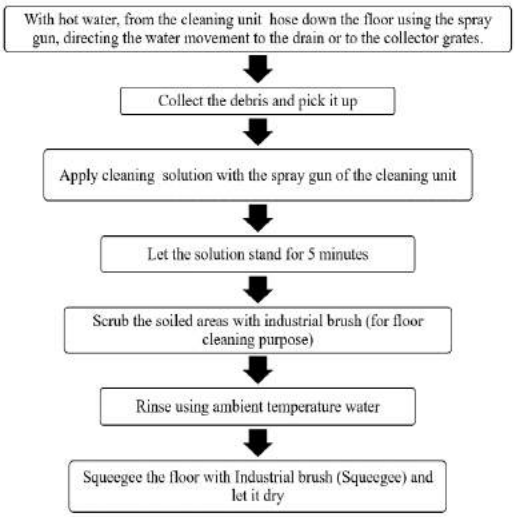

Figure 5. Floor cleaning

Suggested cleaning program: food processing equipment

The cleaning process for equipment was adjusted to overcome the problem with the invisible fat layer which remained on the equipment surfaces. First the meat residues were removed. Then, the equipment was water rinsed. Then by using the portable cleaning unit, hot water of 65°C were sprayed evenly on the surfaces. Cleaning detergent was applied and the surface was brushed using industrial cleaning brushes (Figure (a) to (c) depending on equipment geometry). Then the surfaces were water rinsed. Lastly the surface was sprayed with 75°C hot water as sanitization steps as to ensure that all the potentials foodborne pathogens on the equipment surfaces were eliminated (Heinz and Hautzinger, 2007; Tamime, 2008). Sanitization with hot water can reduce sanitiser usage and lead to a green environment. It can also reduce detergent cost.

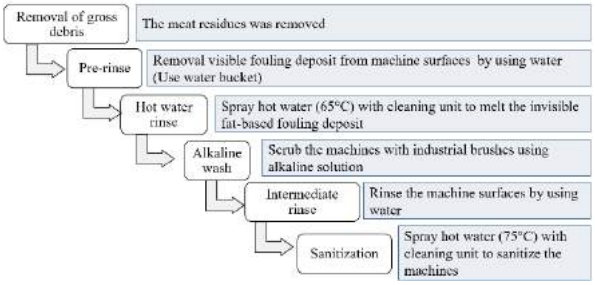

Figure 6. Equipment cleaning

Conclusions

The current cleaning program practice by the SMEs in frozen food industry was unable to reach required cleaning level. All of the food processing equipment (flaker, mincer, bowl cutter, weigh balance, mixer and burger former) and areas (floor and walls) were not physically and microbiologically clean. The invisible fat layer which remained on the equipment surfaces and areas can provide a barrier between microbes and the cleaning solutions. Therefore, a new cleaning program was proposed in this work which included cleaning for the floor, walls and equipment. The proposed cleaning program was assisted with the new cleaning apparatus (industrial cleaning brushes and a portable cleaning unit). The proposed cleaning program not only can produce a hygienic cleaning environment and safe food products but also a safe and healthy working environment for workers.

Acknowledgement

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