

Procedure

Production of soy nuts using hazard analysis critical control point (HACCP)

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Abstract: HACCP procedure has been developed for the production of soy nuts. The protocols include product description, flow diagram of the process, identification of different hazards possible during processing, establishment of critical control points and monitoring and verification of the controls to obtain a high quality product.

Keywords: food processing, soybean, soy nuts, hazard, HACCP, critical limit, critical control

Introduction

In the new millennium it has been estimated that about 840 million people are undernourished and 799 million of these were from developing countries. In India, 233.3 million were undernourished, comprising about 24% of the total population. Undernourishment can be combated through dietary diversity and food fortification along with supplements. In this context soybean (*Glycine max* M) with 40% protein and 20% fat assumes a prominent position in helping to alleviate nutritional imbalance. It not only provides quality macronutrients but also various other essential micronutrients. Efforts are being made to popularize various soy-based foods besides the oil, which is very popular in India. Approximately 9.3 million tonnes of soybean are produced annually in India and 80% is utilized for oil extraction. Only 10% is available for direct food use (Gnathi, 2006). Extruded soy chunks are very popular but quite expensive and beyond the reach of the average population.

Soy nuts are considered as having great potential, as they can be prepared at the domestic level using simple processing procedures. They are a very suitable snack item being popularized all over the globe. HACCP has become synonymous with food safety (FAO/WHO 2001). It is a world wide recognized systematic and preventative approach that addresses biological, chemical and physical hazards through anticipation and prevention, rather than through end-product inspection and testing. The main stimulus for devising the HACCP system was the development of a preventive system for the production of food with a high degree of safety, which is extremely crucial in cases such as a space mission (Pieson and Corlett, 1992). Prior to application of HACCP, the production of soy nuts was in accordance with the Codex General Principles of Food Hygiene, the appropriate Codex Codes of practice and appropriate food safety legislation. Management commitment is necessary for implementation of an effective HACCP system. To date, no study has been made on the production of soy based food using HACCP, with the exception of Gandhi (2008), who developed a similar procedure for the production of full fat soy flour. In the present investigation efforts were made to develop HACCP protocols for producing soy nuts of superior quality with utmost safety.

Materials and methods

The soybean variety JS 335 was obtained from the Institute farm. It was cleaned thoroughly and freed from all dirt, stubble and other foreign matter. It was stored in air tight containers awaiting further use. The nuts were prepared using the standard procedure developed at this centre. AOAC (1990) methods were used for analyzing various chemical constituents and APHA (1984) recommended methods were used for microbiological examination of the products. All the chemicals used were of the analytical grade and the experiments were conducted in triplicate and the mean values were computed for assessment. FAO/WHO (2006) guidelines were used for the preparation of HACCP plans.

Results

Roasted soy nuts are whole soybeans that have been soaked in water and then baked until browned. Soy nuts can be found in a variety of flavours, including chocolate covered. High in protein and isoflavones, soy nuts are similar in texture and flavour to peanuts. The details are given in the Table 1.

Table 1. Product description.

1. Product name	Soy nuts
2. Important product characteristics of end product	$A_w < 0.5$; FFA $< 1\%$; Total microbial counts $< 50000/g$
3. How the product is to be used	Normally taken as such .They are available in different flavours like salted and paprika. They can also be covered with a layer of chocolate.
4. Packaging	Sealed polythene bags or in hermetically sealed metal containers.
5. Shelf-life	8 weeks under normal room conditions.
6. Where the product will be sold	Retail, institutions and food service. Could be consumed as a health food.
7. Labeling instructions	Required to ensure product safety.
8. Special distribution control	No physical damage, excess humidity or temperature extremes.

The identified biological, chemical and physical hazards related to the production of soy nuts, along with a flow diagram of the production process, are given in Table 2, Figure 1 and Table 3.

Table 2. Product ingredients and incoming material.

Raw material	Packaging material	Dry ingredients
Soybeans B, C, P	Polythene bags B, C, P	Silica B, C, P
Other		
Water (municipal) B, C		

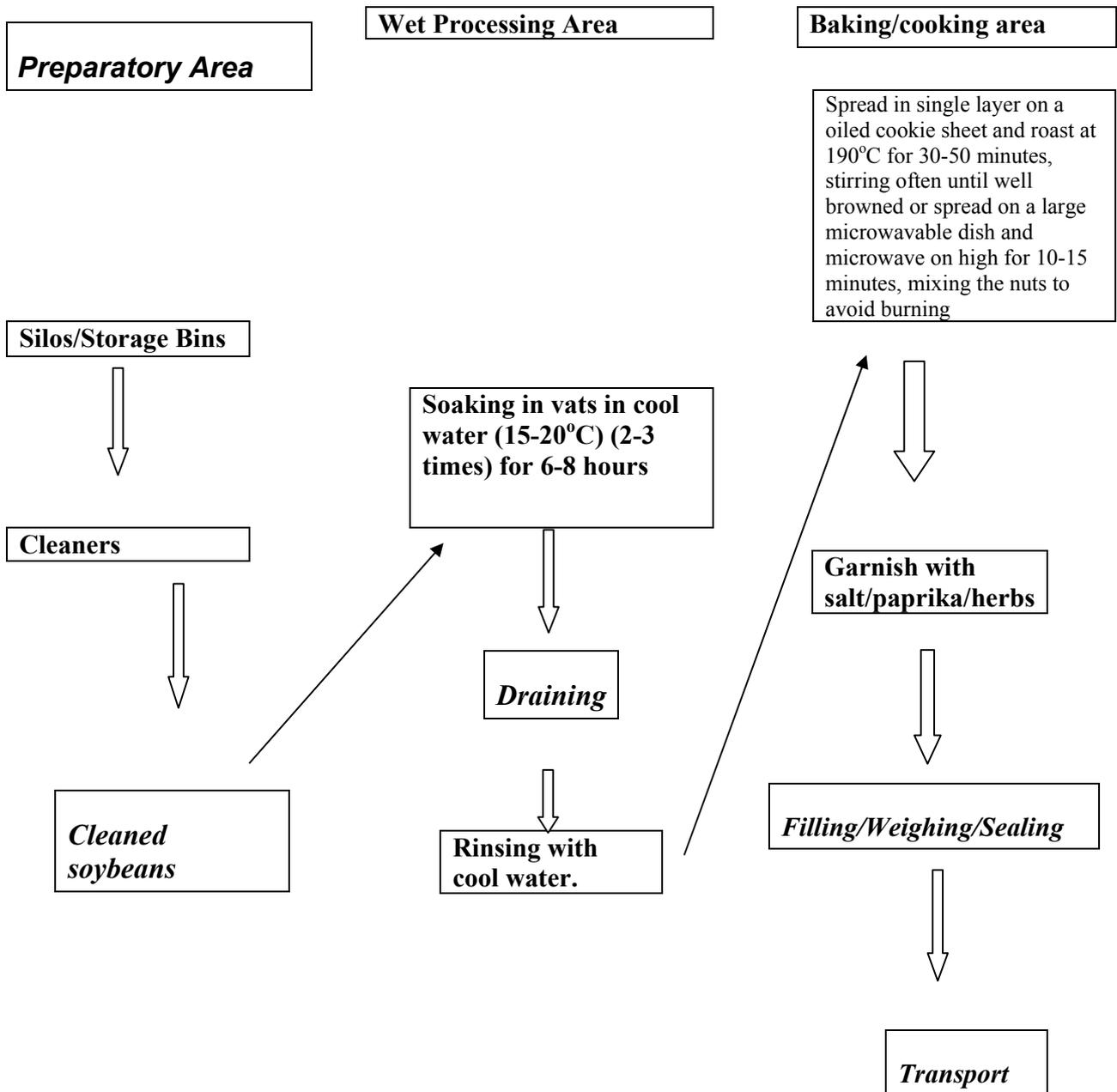


Figure 1. Schematic diagram/floor plan of the production process.

Table 3. Flow of materials and processing.

Soybeans	Packaging material	Dry ingredients	Water
1. Receiving P	2.Receiving P	3. Receiving P	4. In taking
5.Storing B P	6.Storing B C P	7. Storing B C P	
8. Cleaning P	9.Inspecting B P	10. Dumping	
11. Soaking B C			
12. Draining B C			14. Chlorinating
13.Rinsing B P C			
15. Baking B P C			
16.Garnishing BC	17.Filling C P		
	18.Weighing B		
	19.Closing/sealing B		
	20.Inspecting B P		
	21. Labeling B		
	22. Storing B		
	23.TransportB		
P=Physical; B=Biological, C=Chemical			

Details of all the hazards are enumerated as below.

Identified Biological Hazards

Ingredients/materials:

Soybeans

- Could contain soil borne/ airborne pathogenic organisms, yeasts or moulds.

Dry ingredients

- Could contain microbial contaminants.
- Could contain rodent excrements.

Water

- Could contain microorganisms.

Packaging materials

- Could contain defects which could result in leakage.

Processing steps:

Cleaning

- Could be contaminated with microorganisms.

Soaking

- Could contain microorganisms.

Rinsing

- Could contain microorganisms.

Baking

- Could be contaminated with microorganisms.

Weighing

- Overfilling may lead to leakage and prone to contamination.

Transport

- Physical damage to packages results in leakage and contamination of product.

Identified Chemical Hazards

Ingredients/materials:

Soybeans

- Could contain pesticide residues.
- Could contain mycotoxins.

Water

- Could be contaminated with toxic substances.

Processing steps:

Dry ingredients storage

- Could be contaminated with non-food chemicals as a result of improper storage.

Rinsing

- Cleaning chemical residues could contaminate the beans.

Identified Physical Hazards

Ingredients/ materials

Soybeans

- Could be contaminated with harmful extraneous materials namely glass, metal, plastic, wool etc.

Dry ingredients

- Could be contaminated with harmful extraneous materials

Soybean receiving

- Inadequate protection against harmful extraneous material could result in contamination.

Dry ingredient receiving

- Inadequate protection against harmful extraneous material could result in contamination.

The unaddressed hazards are shown in Table 4.

Table 4. Unaddressed hazards.

Unaddressed hazard from previous list	Identified methods of addressing the hazard
Soybeans could contain pesticide residues	Upstream(farm level) programs such as A: Training persons who apply pesticides. B: Purchasing registered pesticides for growers. C: Auditing growers application of pesticides and records there of. D: Requiring periodic pesticide residual analysis reports.

HACCP procedures for general activities are presented in Table 5.

Table 5. HACCP for general activities.

Stage	Activity	Control activity
Raw material harvest	Liaison with the farmers for unit operations like harvesting, threshing and winnowing.	Specifications of grain quality are required. Rejection of under sized seeds.
Raw material transport	Transport in sacks to drying area.	Correct sacking and handling.
Raw material inspection	Sampling and routine inspection.	Correct sampling methods, training and inspection methods.
Preparation of seeds	Cleaning, grading, de hulling, conditioning and blending.	Training operators for equipment, preventing insect infestations, check for moisture content.
Packaging	Filling in to containers and sealing.	Establish specifications for labels and fill weights.

Description of Manufacturing Process

Implementation of HACCP

Receiving soybeans (CCP-1): Soybeans must come from approved dealers. At the time of their receipt they must be accompanied by a complete quality certificate and microbiological assessment reports. The certificates should indicate the moisture content of the beans, degree of foreign materials and the microorganisms present (number of

colonies), insects etc., as compared to the upper approved standards of BIS/ISO. At the time of receipt, visual control of soybeans must be carried out to find out the contaminants, if any. Furthermore, the proximate composition of the beans must be established with reference to their macro and micro nutrients. Defective beans mean that the soy flour will be most likely be unsafe for human consumption.

Receiving secondary materials (greasing, detergents, insecticides, pesticides and sacs) (CCP-2): These materials must be procured from approved suppliers with quality certificates. These materials must be suitable for use with food items. No contamination must come from the packaging materials. If these materials do not comply with the standard specifications, they must be returned to the suppliers and a new order should be placed with other suppliers.

Storage of secondary materials(CCP 3): The temperature and relative humidity during storage must be below 20°C and 65% respectively. The storage area should be air conditioned. The temperature and RH should be continuously recorded and corrective actions must be undertaken whenever any deviation occurs.

Storage of soybeans in silos (CCP-4): The temperature (<20°C) and the relative humidity (<65%) during the storage must be low. They should be recorded at regular intervals. Any deviation from the safe limits must be immediately rectified. When soybean is stored for a long period, microbiological analysis should be carried out.

Application of insect control methods (CCP-5): Any chemicals used during storage along with the soybeans should comply with the safety legislation. The quantity should be within the prescribed concentrations.

Cleaning & grading of soybeans (CCP-6): All the physical contaminants should be removed. They should be graded. Only sound soybeans should be taken for processing. Any stones, metal and dust must be removed from the soybeans so that the final product will comply the quality standards as prescribed by BIS/ISO.

Weighing: The soybeans are weighed and passed through a magnetic system so that any metallic materials are removed.

Soaking of the beans(CCP 7): Prepare the soy before soaking. It will remove the starchy material from the water. Over sprouting and poor drainage causes discolouration and unpleasant odors. Add 2-3 times the volume of cool (15-20°C) water. Mix seeds to assure even water content for all. Allow seeds to soak for 2-12 hours, the shorter the time the better. Check after 2 hours for softening. If they are still hard, let them keep soaking until they are all soft (up to 12 hours). Normally 4 hours is usually the right soak duration. If over soaked they will fall apart.

Draining & rinsing (CCP 8): Drain off the soak water. Rinse thoroughly with cool water (15-20°C). Soy soak water is starchier than most other seeds, so rinse continuously until the water that is drained off runs clear. Drain thoroughly.

Baking (CCP 9): Spread the soybeans in one layer on a well-oiled cookie sheet. Roast at 190°C for 30-50 minutes, stirring often until well browned. Deep frying is an alternative method. Salt the nuts to taste.

Microwave cooking (CCP 9): Spread the soaked beans on a large microwavable dish and microwave on high for 10-15 minutes, until the beans are crispy and golden brown. It is important to mix the soy nuts regularly to avoid burning especially at the end of the process. Flavour the nuts with salt and herbs.

Packaging (CCP-10): During packaging the nuts can possibly be contaminated with microorganisms causing quality deterioration. This can be avoided by hermetic sealing and upright position of the packaging material. There should not be any migration of the low molecular weight substances from the packages. Furthermore, contamination can take place from foreign materials like insects and rodents that accidentally happen to be packed with the flour. The responsible personnel should comply with the Good Manufacturing Processes (GMP).

Storage of soy nuts (CCP-11): Both the temperature and relative humidity must be below 20°C and 65% respectively. They should be recorded and corrective actions must be taken when deviations occur. When the nuts are stored for a long period, microbiological analysis is required.

A step by step description of the procedures is provided in Appendix A, while the nutritive values of the final product are given Table 6.

Table 6. Nutritive values in the product (100 g salted).

Water	2g
Protein	35.0
Fat (total)	25.0g
Carbohydrates	33.0g
Fiber	15.0g
Ash	4.0g

Quality assessment of the soy nuts was undertaken with and without HACCP and the results are presented in Table 7.

Table 7. Quality assessment of soy nuts.

Quality standard expected	Without HACCP	With HACCP
Composition:		
Protein: max. of 36%	32%	35%
Fat: max. of 26%	24%	25%
Carbohydrates: max. of 34%	30%	33%
Crude Fibre: max. of 17%	14%	16%
Ash: max. of 4%	3.2%	4%
Moisture: max. of 3%	4%	2%
Microbiology:		
Total plate count: 20,000/g max	30,000/g	5,000/g
Total coliforms: 100/10g max	120/10g	Nil
Salmonella: Negative/100g	25/100g	Negative
<i>E.coli</i> : Negative/100g	25/100g	Negative
Staphylococcus: 100/10g max.	115/10g	Nil
Yeast: 100/10g max.	100/10g	Nil
Mould: 100/10g max.	102/10g	Nil
TI: less than 75% of original.	<60%	<80%
Urease activity: Nil	Nil	Nil
Available lysine: Min 5.5g/6g N	5.2g/6gN	6.5g/6gN
Sensory parameters:		
Colour: Golden brown	Golden Brown	Golden Brown
Odour: Less beany	Beany	Less beany
Taste: Nutty	Nutty	Nutty
Defects:		
Insect parts: Total absence	Absent	Absent
Foreign material: Total absence	Absent	Absent

Discussion and Conclusion

The results clearly indicate that the nuts produced by implementing HACCP procedures were of better quality when compared to the traditionally prepared ones. This is mainly due to the

adoption of good manufacturing practices, good food hygiene practices and standard operating procedures. The HACCP protocols thus control every stage of processing and yield a better quality and safer product which was missing in the traditional processing. These results indicate the importance of the HACCP for producing safe and quality soy nuts.

HACCP procedures were developed for making soy nuts with utmost quality and safety for consumption. This will enhance their export potential through meeting international standards.

References

1. AOAC. 1990. Official Methods of Analysis. 16th edn. Arlington, VA, Association of Official Analytical Chemists.
2. APHA, 1984. Recommended Methods for Microbiological Examination of Foods, American Public Health Association, New York.
3. FAO/WHO, 2001. Codex Alimentarius, Food Hygiene-Basic texts, Second Edition, FAO/WHO Rome, Italy.
4. FAO/WHO, 2006. FAO/WHO guidance to governments on the application of HACCP in small and /or less developed food businesses, Food and Nutrition paper 86, FAO/WHO Rome, Italy.
5. Gandhi, A.P. (2006) Soybean-the greater bean, **World Grain** (USA), February issue, p 59-62.
6. Gandhi, AP (2008) Development of HACCP procedure for the production of Full fat Soy Flour, **International Food Research Journal** 15(2),141-154.
7. Pierson, M. D. and Corlett, D.A. (1992). HACCP. Principles and Applications. Chapman and Hall, New York.

APPENDIX A

Processing Step	Hazard Description	Critical Control Limit	Observation Procedures	Responsibility	Monitoring Procedures
Soybeans and secondary materials					
Receipt of soybean (CCP1)	Presence of foreign material in soybean (P)	5%	Visual control of sample/control of certifications per lot	Quality Assurance Manager (QAM)	Control of specifications and obtain quality certificates from suppliers
	Growth of microorganisms (B)/insects Fungi (B)	Absence, per lot Out of 5 samples 2 of them 10^2 - 10^4 cfu/g Humidity <13% Protein content 38-40% Other macro and micro nutrients	Visual control of sample/control of certifications per lot Control of the certificates per lot	QAM QAM	Control of specifications and obtain quality certificates from suppliers Evaluation of supplier
Receiving secondary materials (greasing agents, detergents, insecticides, pesticides, sacks etc and storage) (CCP-2&3)	Chemical substances migrating from the secondary materials	Materials suitable for food items	Control of the certificates per lot	QAM	Evaluation of supplier

APPENDIX A cont.

Processing Step	Hazard Description	Critical Control Limit	Observation Procedures	Responsibility	Monitoring Procedures
	The temperature and relative humidity during storage must be below 20°C & 65% respectively. The place should be air conditioned. The temperature and RH should be continuously recorded and corrective actions must be undertaken whenever any deviation occurs.		Control of the certificates per lot	QAM	Evaluation of supplier
Water	Total Coliforms (B)	In agreement with community legislation 80/778 for potable water (B)	Monthly Lab control of water quality	QAM	New drilling at greater depths, chlorination of water
	Faecal Coliforms (B)	In agreement with community legislation 80/778 for potable water (B)	Monthly Lab control of water quality	QAM	New drilling at greater depths, chlorination of water

APPENDIX A cont.

Processing Step	Hazard Description	Critical Control Limit	Observation Procedures	Responsibility	Monitoring Procedures
	Faecal Streptococcus (B)	In agreement with community legislation 80/778 for potable water (B)	Monthly Lab control of water quality	QAM	New drilling at greater depths, chlorination of water
	Sulphur reducing Clostridium (B)	In agreement with community legislation 80/778 for potable water (B)	Monthly Lab control of water quality	QAM	New drilling at greater depths, chlorination of water
	Presence of undesirable & toxic substances in water (e.g., heavy metals, ammonia, hydrocarbons, parasites, nitrates). Excessive quantity of residual chlorine (C)	In agreement with community legislation 80/778 for potable water (B)	Monthly Lab control of water quality	QAM	New drilling at greater depths, chlorination of water
	Presence of foreign material in water (P)	In agreement with community legislation 80/778 for potable water (B)	Monthly Lab control of water quality	QAM	New drilling at greater depths, chlorination of water

APPENDIX A cont.

Processing Step	Hazard Description	Critical Control Limit	Observation Procedures	Responsibility	Monitoring Procedures
Storage of soybeans in silos (CCP-4)	Growth of Microorganisms (B)/insects	Absence	Immediate control, per lot	QAM	Control specifications
	Fungi	In 5 samples 2 of them 10^2 - 10^4 cfu/g, Humidity <13% Temperature <25°C Air conditioning	Daily notices of the results of measuring	QAM	
Application of anti insect control methods at soybean (CCP-5)	Residues of used chemicals	Tolerance levels as prescribed by BIS/ISO	Measuring the amount of chemical per application	QAM	Control of the indication of the weighing machine.

APPENDIX A cont.

Processing Step	Hazard Description	Critical Control Limit	Observation Procedures	Responsibility	Monitoring Procedures
Processing					
Cleaning and grading (CCP-6)	Residues of substances of physical origin in soybean	Absence	Daily control of equipment for appropriate functioning	QAM	Monitoring maintenance of the equipment
Soaking the beans in water (CCP-7)	Water quality, operational parameters	Good quality of water. Dry ingredients of food quality Time/temp of soaking	Quality check and observation of scheduled parameters for each run	Production Manager	Quality assessment of the ingredients and recording of temperature and time schedules
Draining and rinsing with water (CCP 8)	Drain off soak water. Rinse thoroughly with cool water (15-20°C). Soy soak water is starchier than most other seeds, so rinse until water that is drained off runs clear. Drain thoroughly. Set the sprouts away from direct sunlight and at room temp. Rinse and drain again 8-12 hrs. Repeat process, up to 3 times as necessary.	Time and temperature maintenance	Daily quality checks	QAM	Quality assessment

APPENDIX A cont.

Processing Step	Hazard Description	Critical Control Limit	Observation Procedures	Responsibility	Monitoring Procedures
Baking the beans (CCP-9)	Temperature of the oven	190°C for 30-50 minutes	Quality check and observation of scheduled parameters for each run	QAM	Quality assessment
Packaging (CCP-10)	No migration of low molecular weight compounds	Food grade film	Quality check for each lot	QAM	Regular monitoring
Transportation of products	GMP/GFHP (Good Food Hygiene Practices)	Vehicle for food transport	Use anti insect methods and disinfection of the vehicle regularly for maintaining GFHP		
Storage of products (CCP-11)	Control of temperature and RH	Temp. < 20°C RH < 65%	Temp. & RH should be regularly tested. AC unit must be checked regularly for correct functioning.		

APPENDIX A cont.

Processing Step	Hazard Description	Critical Control Limit	Observation Procedures	Responsibility	Monitoring Procedures
Magnet	Metal residues	Absence	Control of equipment every hour	QAM	Regular monitoring
Cleaning in Place	Automatic/manual cleaning of pipe lines, tanks etc.	CIP plant must be SS & consist of tanks for water, lye & acid, disinfectant dosing system, SS centrifugal pump, SS air operated valves & steam heating system	Use set practices like: Pre rinse with water, rinsing with lye, 70°C, flushing with water, rinsing with acid 70°C, flushing with water & finally disinfection		