International Food Research Journal 15(2): 141-154 (2008)

Development of HACCP Procedure for the Production of Full Fat Soy Flour

Gandhi, A. P.

Soybean Processing and Utilization Center,
Central Institute of Agricultural Engineering,
Bhopal-462038(MP), India

Abstract: The Hazard Analysis Critical Control Point (HACCP) procedure aims at ensuring the safety of food products. Such a procedure has been developed for the production of full fat soy flour. The hazards, critical control limits, observation practices and corrective actions have been summarized in comprehensive tables. Furthermore, the production process was meticulously analyzed for drafting the HACCP protocol for the production process.

Keywords: Soybean, full fat soy flour, hazard, HACCP, critical limits, critical controls

INTRODUCTION

About 840 million people were under-nourished and 799 millions were from the developing countries. In India 233.3 millions were undernourished comprising about 24% of the total population. Hence action is needed to save millions of lives every year. This can be done through dietary diversity, food fortification and supplements. In this context soybean (*Glycine max* M) containing 40% protein and 20% fat has a predominant potential in solving the prevailing nutritional imbalances. It not only provides quality macronutrients but also various other micronutrients, which are required to fight against the hidden hunger. Efforts are being made to popularize various soy-based foods besides the oil, which is very popular in India. In India about 6 million tonnes of soybeans are produced annually and 80% is utilized for oil extraction. Only 10% is available for direct food uses. The extruded soy chunks are very popular but too expensive and beyond the purchasing power of the common man. Among various foods, full fat soy flour has a great potential as it can be prepared at domestically using available resources. Today, with the introduction of food quality and safety systems, HACCP has become synonymous with food safety. It is a world wide recognized systematic and preventive approach that addresses biological, chemical and physical hazards through anticipation and prevention rather than through end-product inspection and testing. Prior to the application of HACCP, the production of full fat soy flour should be according to the Codex General Principles of Food Hygiene, the appropriate Codex Codes of practice and appropriate food safety legislation (FAO/WHO 2001). Management commitment is necessary for implementation of an effective HACCP system. In this investigation, efforts were made to draft the HACCP procedures for the production of full fat soy flour.

MATERIALS AND METHODS

The soybean variety JS 335 was obtained from the Institute Farm. It was cleaned thoroughly and made free from all dirt, stubbles and other foreign matter, and then stored in air tight containers till further use. The full fat soy flour was produced using the process developed by Gandhi *et al.* (1984). 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 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.

Corresponding author
E-mail: *apg @ciae.res.in*

Table 1: Product description

1.	Product name	Full Fat Soy flour
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 fortified with other cereals/millets/pulses at 10-15% level in the preparation of traditional recipes.
4.	Packaging	Sealed polythene bags/hermetically sealed metal containers.
5.	Shelf-life	One month at normal retail shelf temperatures.
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.

RESULTS AND DISCUSSION

The full fat soy flour was prepared with and without HACCP procedure for comparison. The detailed protocols were prepared and presented. The product description which should be after final preparation is given in Table 1.

The plant schematic/floor plan is given in Figure 1.

The identified biological, chemical and physical hazards related to the production of full fat soy flour are shown in Table 2 and the flow diagram.

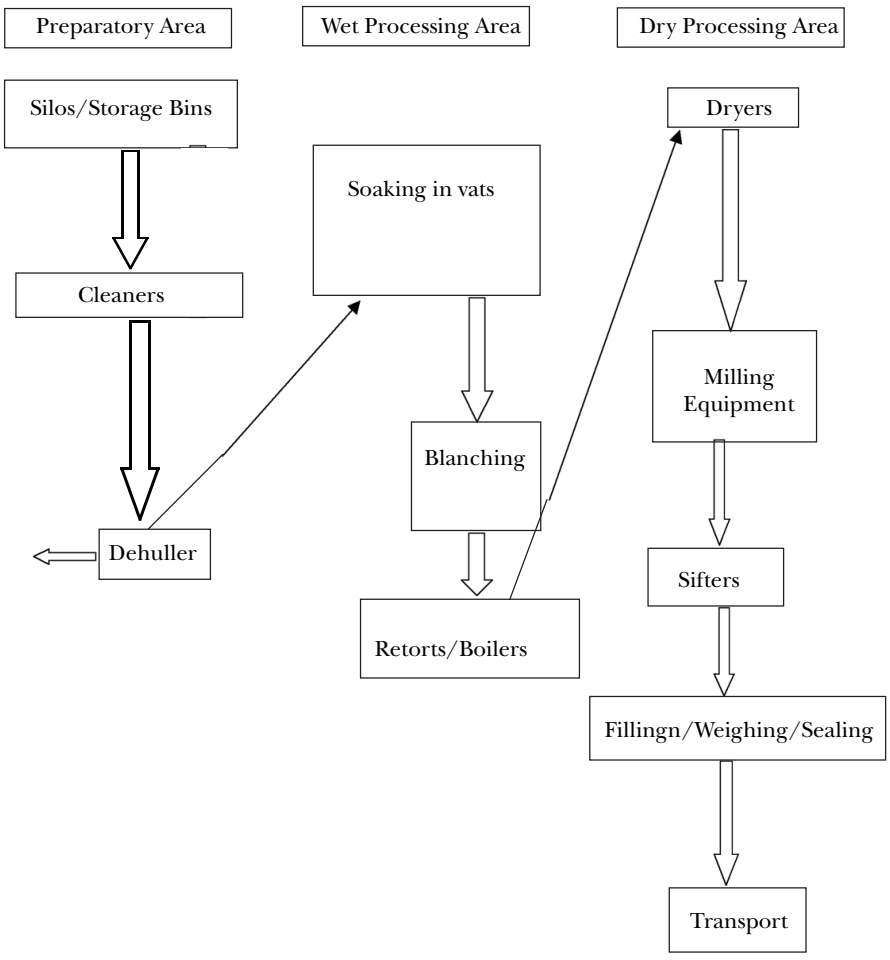

Figure 1: Schematic/floor plan of production of full fat soy flour

Table 2: Product ingredients and incoming material (P=physical; B=biological; C=chemical)

Raw material	Packaging material	Dry ingredients
Soybeans B, C, P Others Water (municipal) B, C	Polythene bags B, C, P	Sodium bicarbonate B, C, P

Flow diagram

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. De hulling P			
12. Soaking B C			13. Chlorinating
14. Blanching B C			
15. Drying B P C			
16. Milling B P C	17. Filling C P		
	18. Weighing B		
	19. Closing/sealing B		
	20. Inspecting B P		
	21. Labeling B		
	22. Storing B		
	23. Transport B		

The next step is identification of Critical Control Points (CCPs). The CCP determination is shown in Table 3.

Some of the hazards not addressed that are connected to this process are presented in Table 4.

The details of all the identified hazards are enumerated below.

	Possible Biological Hazards	Possible Chemical Hazards	Possible Physical Hazards
Ingredients/Materials			
Soybeans	Soil borne/air borne pathogenic organisms, yeasts or moulds	Pesticide residues Mycotoxins	Contamination with harmful extraneous materials namely glass, metal, plastic, wool etc.
Dry ingredients	Microbial contaminants Rodent excrements		Contamination with harmful extraneous materials
Soybeans Receiving			Inadequate protection against harmful extraneous material could result in contamination
Dry Ingredient Storage		Contamination with non food chemicals as a result of improper storage	Inadequate protection against harmful extraneous material could result in contamination
Dry Ingredient Receiving			
Water	Microorganisms	Contamination with toxic substances	
Packaging Material	Defects which could result in leakage		
Processing Steps			
Dehulling	Contamination with microorganisms		
Soaking	Microorganisms		
Blanching	Heat resistant spores	Cleaning of chemical residues could contaminate the beans. If live steam is used, boiled water additives could carry over and contaminate the product	
Drying	Contamination with microorganisms		
Weighing	Overfilling may lead to leakage and prone to contamination		
Transport	Physical damage to packages results in leakage and contamination of product		

Table 3: CCP determination

Instructions:

- Category and identified hazard: Controlled by Codex General Principles of Food Hygiene, if yes indicate GMP and proceed to next hazard. If no proceed to question 1. (Q_1)
- Q_1: Do control preventive measures exist, if no, not CCP; if yes proceed to next.
- Q_2: Is this operation specifically designed to eliminate, if no proceed to Q3. if yes CCP and identify it in the last column.
- Q_3: Could contamination with identified hazards occur in excess of acceptable levels, if no, not CCP. If yes proceed to Q4.
- Q_4: Will subsequent operation control the contamination levels, if no CCP; if yes not CCP.

Process step/ incoming materials	Category and identified hazard	Q_1	Q_2	Q_3	Q_4	CCP
Soybeans	B=Pathogens	Yes	Yes	Yes	Yes, thermal processing	
	C=Pesticides	No(farmers/growers level-GPP)				
	C= heat stable toxins	No(farmers/growers level-GPP)				
	P= harmful extraneous material(HEM)	Yes(visual inspection and foreign object removal)	Yes	Yes	No	
Packaging materials	B=pathogens	Yes	Yes	Yes	Yes, sterilization	
Dry ingredients as delivered	B= bacterial spores B=rodent excretes(GMP) P=HEM(GMP)	Yes	N/a	Yes	Yes, thermal processing	
Water at intake	B= GMP C= heavy metals & other toxins(GMP)					
Cleaning and grading of soybeans	P=GMP					
Dehulling of soybeans	B	Yes	Yes	Yes	No	CCP-1 (Hulls %)
Soaking of soy splits	Water(GMP)Sodium bicarbonates (0.5%)					
Blanching in water	B C	Yes	Yes	Yes	No	CCP-2 (time and temperature of water)
Drying	B	Yes C	Yes	Yes	No	CCP-3 (Moisture content and time allowed for drying)
Attrition	B(GMP)					
Sifting	P(GMP)					
Filling	P(GMP)					
Weighing	P(GMP)					
Packaging and sealing	B	Yes	Yes	Yes	No	CCP-4 (Proper gauge and sealing clearance)

Table 4: Hazards not addressed

Hazard not addressed in previous list	Identified methods to address the hazard
Soybeans could contain pesticide residues	Up stream (farm level) programs such asA: Training persons who apply pesticides.B: Purchasing registered pesticides for growers.C: Auditing growers application of pesticides and records there of.D: Ensure/request periodic pesticide residual analysis reports.

The detailed HACCP plans are shown in Tables 5 and 6.

Table 5: HACCP Plan

Process step	CCP No	Hazard description	Critical limits	Monitoring procedure	Deviation procedures	HACCP records
Dehulling	1	Inefficient dehulling may cause contamination of the product with micro organisms.	Less than 0.1%	On line check of the sample	Line operator to adjust the clearance of the de huller drums.	Operator log book
Blanching/ cooking	2	Inadequate heat treatment	Cook the splits as specified in the scheduled process (under pressure/open vessel boiling)	Check the quality of splits for urease test	Operator should adjust the time and temperature following the authorized contingency plan and to inform the QC.	Operator log book.
Drying(Sun/ mechanical)	3	Improper drying	The moisture content should be less than 8%-10%.	Check the moisture content following the guidelines.	If moisture content is greater the splits may be dried again and inform QC	Operators log book.
Packaging and sealing	4	Over filling, improper gauge polythene and improper sealing	Maximum fill weight as specified in the scheduled process. Proper sealing leaving recommended space.	Online check to reject over and under filled bags and improperly sealed bags.	Line operator to adjust the settings.	Operators log book and quality control report.

Table 6: 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, dehulling, conditioning and blending.	Training operators for equipment, preventing insect infestations, check for moisture content.
Milling and sieving, Dehulling and expelling	Separation of components of seeds	Training in hygiene, implementation of cleaning, assessment of product quality.
Packaging	Filling in to containers and sealing.	Establish specifications for labels and fill weights.

Description of Full Fat Soy Flour Manufacturing Process: Implementation of HACCP

Receiving Soybeans (CCP-1): The soybeans must be obtained from approved dealers. At the time of its receipt it must be accompanied with its complete quality certificate and microbiological assessment reports. The certificates should indicate the moisture content of the beans, degree of foreign materials, the micro organisms present (number of colonies) and insects 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 its macro and micro nutrients. Defective beans mean that the soy flour will most likely be unsafe for consumption.

Storage of Soybeans in Silos (CCP-4): The temperature (<20°C) and relative humidity (<65%) during the storage must be low and 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.

Receiving Secondary Materials (Greasing, Detergents, Insecticides, Pesticides and Sacs) (CCP-2): These materials must be procured from the approved suppliers with quality certificates. These materials must be suitable for use on 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: The temperature and relative humidity (RH) during storage must be below 20°C and 65% respectively. The storage should be air conditioned. The temperature and RH should be continuously recorded and corrective actions must be taken whenever any deviation occurs.

Application of Anti Insect Methods (CCP-5): Any chemicals used during storage along with the soybeans should comply with the safety legislations. The quantity should be within the prescribed concentrations.

Cleaning and Grading of Soybeans (CCP-6)*:* All the physical contaminants should be removed and the soybeans graded. Only sound soybeans should be taken for processing.

Removal of stones: The stones, metals and dust must be removed from the soybeans so that the final product will comply with the quality standards as prescribed by BIS/ISO.

Storage of Soybeans in Silos: The temperature and relative humidity must remain low i.e. <20°C and <65% respectively. These should be recorded regularly and corrective actions should be taken when deviations occur. When stored for a long time, microbiological analyses should be done.

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

Milling: Grinding is done in a burr/hammer mill. The clearance between the burrs should be adjusted so that the flour particle size <140 micrometers. Similarly for the hammer mill, the sieve below the grinding system must allow flour particles less than 140 micrometers. The sieves should be stainless steel. The temperature during grinding should not rise too much to a level which could affect the quality of the flour. Normally a temperature rise of less than 5°C is desirable. So facilities must be in place to maintain the temperature during grinding.

Storage of Flour (CCP-8): Both the temperature and relative humidity must be below 20°C and 65% respectively. These should be recorded and corrective actions must be taken if there is any deviation. When the flour is stored for a long period, microbiological analysis is required.

Packaging (CCP-10): During packaging, the flour can possibly be contaminated with microorganisms causing quality deterioration. This can be avoided by hermetic sealing and upright positioning 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. Packaging personnel should comply with Good Manufacturing Process, (GMP).

Metal Detector (CCP-7): The packed product passes through a metal detector. The product is then checked for its weight and placed in boxes (secondary packaging). The boxes are placed on pallets and the packets are wrapped with film.

Storage: The storage temperature and relative humidity must be below 20°C and 65% respectively and the store should be air conditioned. Both the temperature and relative humidity must be recorded regularly and corrective actions must be taken whenever deviations occur.

The synoptical presentation of HACCP is shown in Table 7.

The results indicate the importance of the HACCP for producing safe and quality full fat soy flour.

Table 7: Synoptical presentation of hazards, critical control limits, observation procedures and control actions for the production of full fat soy flour

Processing step	Hazard description	Critical Control Limit	Observation procedures		Responsible	Monitoring procedures	Corrective actions
			Control of CCP	Frequency			
Receiving of soybean (CCP-1)	Presence of foreign material in soybean (P)	5%	Visual control of sample	Per lot	Quality Assurance Manager (QAM)	Control of specifications and procure quality certificates from suppliers	Rejection of lot or change supplier
			"			"	
	Growth of micro organism (B)/insects	Absence	Control of the certificates per lot	"		Evaluation of supplier	"
	Fungi (B)	Out of five samples two of them 102-104.				"	" "
		Humidity <13% Protein content 38-40% Other macro and micro nutrients					
Receiving secondary materials (greasing/ agents, detergents,	Chemical substances migrating from the secondary materials.	Materials suitable for food items.					

Table 7: Continued...

Processing step	Hazard description	Critical Control Limit	Observation procedures		Responsible	Monitoring procedures	Corrective actions
			Control of CCP	Frequency			
insecticides, pesticides, sacs etc (CCP-2)							
"	"	"	"	"			
Water(CCP-3)	Total Coli forms (B)	In agreement with the community legislation 80/778 for potable water (B)	Lab control of water quality	Monthly"	QAM	New drilling at greater depths, chlorination of water	New drilling
	Faeces Coli forms (B)	"	"	"	"	"	"
	Faeces Streptococcus (B)	"	"	"	"	"	"
	Sulphur reducing Clostridium (B)	"	"	"	"	"	"
	Presence of undesirable and toxic substances in water (eg. Heavy metals, ammonia, hydrocarbons, parasites, nitrates). Excessive quantity of residual chlorine (C)	"	"	"	"	"	"
	Presence of foreign material in water (P)	"	"	"	"	"	"
Storage of soybeans in silos (CCP-4)	Growth of micro organisms (B)/insects	Absence	Immediate control	Per lot	QAM	Control specifications	Use them immediately
	Fungi	In five samples two	Notices of the	Daily			

Table 7: Continued...

Processing step	Hazard description	Critical Control Limit	Observation procedures		Responsible	Monitoring procedures	Corrective actions
			Control of CCP	Frequency			
		of them 10^2-10^4 Humidity <13% Temperature <25°C Air conditioning	results of measuring.				
Application of anti insect methods at soybean (CCP-5)	Residues of the used chemicals	Tolerant levels as prescribed by BIS/ISO	Measuring the amount of chemical	Per application	QAM	Control of the indication of the weighing machine.	“ “
Presence of physical contaminants (CCP-6)	Residues of substances of physical origin in soybean.	Absence	Control of equipment for appropriate functioning	Daily	QAM	Monitoring maintenance of the equipments	Repetition of produces calibration of equipment.
Magnet (CCP-7)	Metal residues	Absence	Control of equipment	Every hour	QAM	“	Repairing of the equipment
Storage of products	Control of temperature and RH	Temperature < 20°CRH < 65%	Temperature and RH should be regularly tested. AC unit must be checked regularly for its functioning.				
Transportation of products	GMP/GFHP	Vehicle for food transport.	Use anti insect methods and disinfection of the vehicle regularly for maintaining GFHPs.				

Table 7: Continued...

Processing step	Hazard description	Critical Control Limit	Observation procedures		Responsible	Monitoring procedures	Corrective actions
			Control of CCP	Frequency			
Cleaning in Place	Automatic/manual cleaning of pipe lines, tanks etc.	CIP plant must be SS and consists of tanks for water, lye & acid, disinfectant dosing system, SS centrifugal pump, SS air operated valves and steam heating system.	Use the set practices like: Pre rinse with water, rinsing with lye,70°C, flushing with water, rinsing with acid 70°C. flushing with water and finally disinfection with disinfectant.				
Dehulling of oybeans (CCP)	Presence of hulls in the splits.	5% or absence.	Control of dehuller, adjustment of clearance.	Every run	Production Manager	Monitoring and maintenance of the dehuller	Precautionary maintenance or else replace with new system.
Steeping in water	Water quality, operational parameters	Good quality of water.Dry ingredients of food qualityTime/temp of soaking	Quality check and observation of scheduled parameters.	Every run	Production Manager	Quality assessment of the ingredients and recording of temperature and time schedules.	Repetition of the testing results and incase of deviation rejection of lot.
Blanching / steaming	Water quality, operational parameters.	Good quality of water, time and temperature of holdings.	QC and recording of parameters.	Every run.	Production Manager.	Constant monitoring of the scheduled	Repetition of the testing results and

Table 7: Continued...

Processing step	Hazard description	Critical Control Limit	Observation procedures		Responsible	Monitoring procedures	Corrective actions
			Control of CCP	Frequency			
						process.	in case of deviation rejection of lot.
Drying	Drying temperature and time	Low temperature drying for qood quality. MC around 10 % (wb).	QC and recording of parameters.	Every run.	Production Manager	Evaluation of moisture of the dried splits in the lab.	Repetition of the testing results and incase of deviation rejection of lot.
Attrition	Grinding system and temperature rise	Minimum temp rise.	QC of the milled product.	Every run.	QAM	Laboratory check up and evaluation.	Repetition of the assessment and in case of deviation rejection of the lot.
Sifting	Desired granular size.	As per recommended mesh size.	QC of the final product.	Every run.	Production Manager	Regular monitoring.	In case of deviation the system may be replaced.
Packaging	No migration of low molecular weight compounds.	Food grade film.	QC	Every lot	QAM	Regular monitoring.	Replace the lot.

The quality of the product prepared with and without HACCP is shown in Table 8.

Table 8: Continued

Quality standard expected	With HACC	Without HACC
Composition		
Protein:		
Minimum = 35%	P35%	P40%
Fat:		
Minimum = 18%	17%	20%
Crude Fiber:		
Maximum = 4%	5.2%	3.8%
Ash:		
Maximum = 6.5%	5.4%	6.3%
Moisture:		
Maximum = 10%	10%	8%
Physical parameters		
Granulation:		
90% minimum pass through US sieve 200 (0.074 mm)	75%	95%
Microbiology		
Total plate count:		
20,000/g maximum	50,000/g	10,000/g
Total coli forms:		
100/10g maximum	120/10g	Nil
Salmonella:		
Negative/100g	10/100g	Nil
E.coli		
Negative/100g	15/100g	Nil
Staphylococcus:		
100/10g maximum	135/10g	Nil
Yeast:		
100/10g maximum	100/10g	Nil
Mold:		
100/10g maximum.	123/10g	Nil
Protein solubility:		
PDI 20-80%	25%	75%
TI:Less than 75% of original.		
Urease activity: Nil	<50%	<80%
Available lysine:	Nil	Nil
Minimum 5.5g/6g N	4.2g/6gN	6.2g/6gN
Sensory parameters		
Color:		
Creamy to yellow	Yellow	Creamy
Odor:		
Less beany	Beany	Less beany
Taste:		
Nutty	Nutty	Nutty
Defects		
Insect parts: Total absence.	Absent	Absent
Foreign material: Total absence.	Absent	Absent

CONCLUSION

HACCP procedures were developed for making full fat soy flour with utmost quality and safe for use. It will have great export potential and of International standards.

REFERENCES

AOAC. 1990. Official methods of analysis. 16th edn. Arlington, VA: Association of Official Analytical Chemists.

APHA. 1984. Recommended methods for microbiological examination of foods. New York: American Public Health Association.

FAO/WHO. 2001. Codex alimantarius, food hygiene-basic texts. 2nd edn. FAO/WHO Rome, Italy.

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.

Gandhi, A.P., Nenwani, M.M. and Ali, N. 1984. Production of full fat soy flour at the rural level. Journal of Food Science and Technology, 21 (4): 219-222.

The Hazard Analysis Critical Control Point (HACCP) procedure aims at ensuring the safety of food products. Such a procedure has been developed for the production of full fat soy flour. The hazards, critical control limits, observation practices and corrective actions have been summarized in comprehensive tables. Furthermore, the production process was meticulously analyzed for drafting the HACCP protocol for the production process. anticipation and prevention rather than through end-product inspection and testing. Prior to the application of HACCP, the production of full fat soy flour should b Officially known as "full-fat soy flour," this is the most natural and lightly-processed product, containing all of the oil naturally present in the soybean; it typically contains 18-20% fat and 39-41% protein. To make whole soy flour, whole soybeans are steamed, dried to less that 5% moisture, cracked, dehulled, and ground, or extrusion cooked and ground.Â This active enzyme, the only soybean enzyme given commercial application, forms hydroperoxides, which bleach carotenoid pigments in the production of white bread. Up to 0.5% enzyme active soy flour, based on the weight of the bread flour, is used in white breads. (The near-raw flour has a prominent beany-grassy flavor and odor before baking.) Production of flour confectionery products.Â 1.1 The essence and procedure for the development of the HACCP quality system â€¦â€¦â€¦â€¦ 4. 1.2 System Introduction and Area of Distribution â€¦ ..Â HACCP system controls at all stages of the food chain, any point in the process of production, storage and sale of products, where dangerous situations may arise. Special attention is paid to the critical control points, in which all of the risks associated with the consumption of food, can be prevented, eliminated, and reduced to an acceptable level as a result of targeted control measures. 36 Full PDF related to this paper. Implementation of hazard analysis critical control point (HACCP) system to the fish/seafood industry: a review. Download.Â Developing an HACCP plan includes formation of an HACCP team, description of the product, definition of product use, development of the flow chart, verification of the flow chart, recording of hazards and predictive measures, identification of CCPs based on the decision tree, definition of CLs, installation of a CCPs monitoring system, definition of corrective actions, installation of recording system, and determi- nation of. HACCP verification procedure (FAO/WHO, Codex Alimentarius, 1993).