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Implementation of Iso 22000 as a Food Safety Management Tools in Wheat Milling Industry

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Abstract: Wheat products (flour and semolina) are of great importance in the Egypt diet. Although food poisoning not frequently recorded, it is a very common phenomenon in Egypt. Food poisoning symptoms in the mild stages go unnoticed because the sufferer gets treated for the symptoms that include diarrhea (sometimes bloody), vomiting, nausea or stomach cramps but rarely samples are drawn to identify the cause of the illness. The United States of America and the United Kingdom have more concrete evidence and statistics that can trace the micro-organism involved. The overall view is that food safety receives very little attention although it has been suggested that the food should be safe from farm to fork. Therefore, it is advised that food safety should be controlled by having a food quality management system (FSMS) in place. Such a system includes the pre-requisite programs and a HACCP plan which able to ensure that all factors affect the quality of the product are under control. In terms of the regulations in Egypt, FSMS will become mandatory especially if they want to export to European Union countries since December 1995 and to the United States of America since December 1997. ISO 22000 is used as a tool for trade barrier since it has become a requirement for export. Therefore, there was a need within the milling industry for controlling food safety especially due to customer's demands and government's regulations. The best way to ensure food safety was with the implementation of (FSMS) which represented in ISO 22000. Accordingly the principal aim of this study was to develop a generic FSMS model for the flour milling industry. Afterwards this generic model could then be adapted for each specific mill and its needs

Key words: Wheat flour · ISO22000 · Milling industry · Food safety · Flour microbiology

INTRODUCTION

Egypt is the most populous country in the Arab world and the second most populous in Africa behind Nigeria and the first country in importing wheat (Egypt is the world's largest wheat importer, importing an estimated 8.3 million tons in the 2011/12 marketing year [1]. This wheat consumed yearly in many phases (bread which by government is subsidizes, pasta and pastries ….etc.); so that Egypt gives a priority to wheat milling process because it's a strategic industry. Flour is produced from wheat kernels, with the aid of the milling process. Milling aims at separating the wheat endosperm from the bran coating and embryo or germ and consequently comminuting the endosperm to a fine powder. Flour comprises a mixture of endosperm particles with starch granules and protein matrix particles [2]. The flour milling industry is considered a low risk area within the food handling enterprises, since the flour is mainly used for baking purposes. However, there are pathogens, that which might produce toxins heat stable and can cause illness even after the product has been baked, such as *Bacillus* and *Staphylococcus* species. In some cases the flour does not undergo heat treatment (cooking or baking) such in the case of flour used for candy coatings and in such cases consumers are at risk of contracting food poisoning. In other cases where the flour are used in sauces, the heat treatment sometimes are not at the extreme and the chance that the micro-organisms are not killed off completely, exist. Flour is generally regarded as a microbiologically safe product because it has a low water activity commodity. Although the growth of pathogenic bacteria may not be supported under such conditions, pathogens that contaminate flour may survive for extended periods [3]. There is little information on the micro-flora of wheat and flour or the influence of milling

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practices on the microbiological quality and safety of flour and other end products. Substantial amounts of data were generated in some studies as reported by Eyles *et al*. [4] and Hesseltine and Graves [5]. However, there may also be a significant body of data from ongoing monitoring and quality assurance by the flour milling industry that is not in the public domain. In the same time, there is little information on the micro-flora of wheat and flour or the influence of milling practices on the microbiological quality and safety of flour and other end products.

There was a need within the milling industry for controlling food safety especially due to customer's demands and government's regulations. The best way to ensure food safety was with the implementation of ISO 22000 as a tool for food safety system. Food borne disease and some outbreaks like *E. coli*; salmonellosis; yeast and Moulds as a source of Aflatoxin resulted in consumer mistrusts ; so that many organization providing food safety management systems (FSMS)to find a standard criteria to prevent any outbreak could be occur and to define an effective documentation system to assist tracing back the production process flow. Other methods were instructed to control the hazarded point in the process of production like hazard analysis critical control point (HACCP). Nowadays, The ISO 22000 international standard specifies the requirements for a food safety management system that involves interactive communication, quality management system, prerequisite programs and the HACCP principles [6-13]. Therefore, ISO 22000 becomes one of the most important standards in the food industries filled. On the other hand, consumers have become increasingly concerned about the food safety and the quality of their food product [14]. Accordingly the aim of this study was to develop a generic FSMS model during wheat flour milling industry based on the ISO 22000.The prerequisite programs were developed in order to control the microbial, chemical and physical hazards in wheat flour during milling process and set up corrective actions maintaining the safety of final product.

MATERIALS AND METHODS

This study was carried out during 2010-2011 in one of companies for wheat milling industry, located in the industrial zone of Badr city Sharkia Governorate, Egypt. The company involved in many kind of wheat flour milling producing beaker flour (BF); semolina flour (SF); Pastry flour (PF).

Sampling: Samples of raw wheat grains were collected up on receiving during the cleaning and the storage steps of grains. Other stages of sampling were carried out during the different milling steps of wheat flour. Sampling methods were carried out according to ES: 1251-2 [15].The samples from processing surfaces and hands of plant workers were taken by swab method according to Stinson and Tiwari [16].

Analytical Methods: Moisture content of raw wheat grains and wheat flour samples was determined according to A.O.A.C [17].

Microbiological Analysis: Microbiological analysis of different samples taking from raw wheat grains, different wheat flour, water, processing surfaces and hands of plant workers were determined as follows: Total Viable count [18]. Coliforms group [19]. *Staphylococcus aureus* Coagulase-positive [20]. Fecal streptococci [21]. *Salmonella* sp. [22] and MICROBACT 12A (from oxoid) for biochemical confirmation and polyvalent O-I (from Defco); yeast and Moulds [23]. Aerobic and anaerobic spore former using [24]. *Bacillus ceruse* [25] and swab samples [26].

Application of Food Safety Management System Program

Listing the Prerequisite Programs: The prerequisite programs (PRPs) represent the conditions and/or the necessary basic activities to develop a generic FSMS model during wheat flour milling industry were evaluated according to ES: 3393 [27] and ES: 3856 [28].

Application of HACCP System: According to ISO 22000 [6] HACCP system was applied based in the following seven principles: 1. Conduct a hazard analyses, 2. Identify the critical control points (CCPs), 3. Establish critical limits for preventive measures associated with each identified CCP, 4. Establish CCP monitoring requirements, 5. Establish corrective actions to be taken when monitoring indicates then a deviation from an established critical limit, 6. Establish verification procedures and 7. Establish record-keeping and documentation procedures. Flow diagram of wheat milling processing line was constructed in order to provide a clear, simple description of the steps involved in the process. CCPs were determined according to the decision tree as described by CAC/RCP1-1969 (Rev.4-2003) [29]. The wheat milling line was summarized with reference to hazard analysis results and CCPs and their monitoring on the HACCP worksheet.

RESULTS AND DISCUSSION

Implementation Steps of the ISO 22000 Standard

Listing the Prerequisite Programs (PRPs): The PRPs represent the conditions and/or the necessary basic activities to maintain a hygienic environment for the production, handling and the provision of safe finished products all along the food product process. The prerequisite programs should be established in the processing line before applications of FSMS were determined using chick list according to ES: 3393 [27] and ES: 3856 [28] and the results are presented in Table 1, it could be noticed that, location and design of the milling processing line, walls, doors, devices and machines and disposals tanks were satisfactory constructed according to the criteria listed in ES: 3393 [27] and the objectives evidences are listed in Table 1. On the other hand, quality control and its device was not applicable where no monitoring for the temperature of the milling processing line and no monitoring control for the safety of water used in the milling processing line. The infrastructure of wheat milling processing line under investigation was evaluated and it was satisfactory according to the criteria listed in ES: 3393 [27], except aeration and quality of air was unsatisfactory as there in no document of quality control of air used in the milling processing line (Table 1). From the same table it could be observed that, monitoring of necessary hygienic principles in the milling processing line was not applicable.

After the surveillance of the prerequisite programs for the milling processing line under investigation, the unsatisfactory and not applicable criteria were reviewed with the management of establishment to undertake the corrective actions establishment of before application of FSMS. In the same time, microbiological analysis of water samples, swabs from working surfaces and different air samples from different areas of milling processing line under investigation ware conducted and the results were as follows: Microbiological analysis of different water samples from wheat milling processing line under investigation were illustrated in Table 2. It could be noticed that, water used in the milling processing line was in high microbiological quality, since the result of microbiological criteria tested in any water samples during different investigation periods expressed, as total plate count, coliform group, *E. coli* and fecal Streptococci were not detected at detection limit (10^1 cfu/ml). According to reference [21] for water used in food establishment the microbiological quality of water were acceptable. Water has an important technological role during wheat milling process as it used in conditioning step before milling, cleaning and disinfection of machines and in personal hygiene. The results of microbiological analysis of air samples collected from different areas of milling processing line under investigation are shown in Table 3. Different air samples were collected from different processing areas of milling line as areas listed in Table 3. Total bacterial count of collected air samples was 2.30, 1.97, 2.05, 2.40, 2.32, 2.00 2.09 log cfu/plate for areas of control room + miller and breaker, control sieves + carter disc, cleaning machines + bran brushes, main sieves, conditioning area + flour silos, bran storage and flour storage + motors + calendars, respectively during Autumn. On the other hand, total bacterial count of air samples collected from the aforementioned areas during spring was 2.10, 1.86, 1.86, 2.27, 2.21, 1.96 and 1.80 log cfu/plate, respectively. It could be noticed there is a little variation in values of total bacterial count of collected air samples during different investigation periods, which indicate the high microbiological quality of air in milling processing areas.

Concerning the conditions of personal hygiene of workers in milling processing line under investigation swab samples were taken from their hands during working day at different investigation periods and the results are shown in Table 4. Swab samples of hands of workers were tested for total plate count, counts of coliform group, *S. aureus* and Moulds and then detected for presence of Salmonella. The aforementioned parameters were chosen as microbiological criteria for the evaluation of personal hygiene as listed in many studies [31]. According to the results presented in Table 4, it could be noticed that, total plate count of swabs from hands of plant workers in the range of 3.00 to 1.50 log cfu/swab during the investigation period of Autumn, while it was ranged from 2.00 to 1.48 log cfu/swab during spring period. In the same time, counts of Moulds were ranged from 2.13 to 1.00 and from 1.54 to <9 log cfu/swab during the aforementioned investigation periods, respectively. About the microbiological criteria of concern, there are no references or standards listing the limits accepted or unaccepted for these criteria, but it varies according the natural of establishment and types of food products. The obtained results could be accepted according to the standard established by the food establishment under investigation. For this, swab samples of plant workers were tested also for both of coliform group and *S. aureus* as criteria used for evaluation of hygienic conditions for workers in food establishments, as listed in ES: 3393 [27]. According to the results which were listed in Table 4,

Table 1:Observations results of the check prerequisite programs in wheat milling processing line

		Compliance			
Location	Assessment criteria	S	U	NA	Objective evidence/comments
Location of the milling	[27]. (3-1)	√			Miller were built in industrial zone which the government supplemented with all facilities for manufacturing
Design Buildings external	[27]. (3-1)	√			supplemented with all facilities for manufacturing
Buildings internal	[27]. (3-1)	√			supplemented with all facilities for manufacturing
Walls	[27]. (3-2)	√			Covered with glazed ceramic (easy to clean)
Doors	[27]. (3-2)	√			Bound with rubber selling with forced air blinds
Devices and machines	[27]. (4-1)	√			In place and areas accepted for maintenance
Quality control and its device	[27]. (4-2)			√	1. No monitoring for the temperature of the milling processing line 2. No monitoring control for the water
Disposals tanks	[27]. (4-3)	√			In place
The infrastructure[27]. (5)					
Water	[27]. (5-1)	√			Supplied from government and have a store tanks for it
Sewage	[27]. (5-2)	√			Supplied from government
Windows	[27]. (3-2)	√			Bound with rubber selling
Cleaning	[27]. (5-3)	√			in place
Bathrooms	[27]. (5-4)	√			in place
Temperature monitoring	[27]. (5-5)			√	No devices for this category
Aeration and quality of air	[27]. (5-6)		√		No document of quality control for that
Lightness	[27]. (5-7)	√			
Storage	[27]. (5-8)	√			
Operation control [27]. (6)					
Control of hazard points	[27]. (6-1)	√			Using HACCP system
Basics of hygienic principles	[27]. (6-2-1)				
	temperature and time			√	No monitoring devices for this issue
Microbiological criteria	• [27]. (6-2-3&4)§				
	• [29].				
	•[30].				
	• [27]. (6-2-5&6)		√		
Filling	• [27]. (6-4)	√			Using a woven bags printed with edible ink
Maintenance and sanitations	• [27]. (7)				
Pest control	[27]. (7-3)	√			Effective and implemented
Waste management	[27]. (7-4)	√			
Personal hygiene	[27]. (8)			√	Not controlled and there are no document for that
Visitors	[27]. (9)		√		No special clothes for visitor or overshoes or overhead available

S: satisfactory - U: unsatisfactory - NA: not applicable

Table 2: Microbiological analysis of water samples used in wheat milling line

	Time of Investigation			
Microbiological analysis (Log cfu/ml)	Autumn		Spring	
Total plate count	<1	<1	<1	<1
Coliform group	<1	<1	<1	<1
E. coli.	<1	<1	<1	<1
Feacal Streptococci	<1	<1	<1	<1

<1: viable colony was not detected at detection limit < 10^1 cfu/ml

Table 3: Total bacterial count (Log cfu of investigation number/ plate)of air samples collected from different milling areas during different investigation periods

	Time of Investigation	
Milling area	Autumn	Spring
1stFloor (control room)+ miller and breaker	2.30 ± 0.30	2.10± 0.42
2nd Floor Control sieves +carter disc	1.97± 0.30	1.86± 0.14
3rdFloor Cleaning machines +bran brushes	2.05± 0.17	1.86± 0.27
4thFloor main sieves	2.40± 0.1	2.27± 0.17
5thFloor conditioning area + flour silos	2.32± 0.2	2.21± 0.21
Bran storage area	2.00± 0.46	1.96± 0.33
Flour storage area +motors + calendars	2.09± 0.29	1.80± 0.26

± : standard deviation

Table 4: Microbiological analysis of swabs from workers is in touch with the product during different investigation periods.

		Microbiological analysis				
Visit number		Total plate count#	Coliform group#	S. aureus#.	Salmonella sp*.	Moulds & yeast#
First	Autumn Investigations	2.00	<9	<9	Not detected	1.80
		2.43	1.56	<9	Not detected	2.13
		3.00	<9	<9	Not detected	1.56
		2.86	<9	<9	Not detected	1.73
Second		1.70	<9	<9	Not detected	1.48
		2.08	<9	<9	Not detected	1.65
		1.50	<9	<9	Not detected	1.00
		2.00	<9	<9	Not detected	1.30
Third	Spring Investigations	1.48	<9	<9	Not detected	1.54
		1.95	<9	<9	Not detected	1.40
		2.00	<9	<9	Not detected	1.54
		1.65	<9	<9	Not detected	1.30
Fourth		1.00	<9	<9	Not detected	<9
		1.60	<9	<9	Not detected	<9
		1.54	<9	<9	Not detected	<9
		1.65	<9	<9	Not detected	<9

*: detected or not detected in swab sample

#: log cfu/swab

<9: viable colony was not detected at detection limit < 10^1 cfu/g

counts of coliform group and *S. aureus* were <9 indicating that the count was not detected at detection limit < 10^1 cfu/g. In the same time, Salmonella was not detected in any tested swab samples. These results could be due to the highly attention of personnel hygiene and sanitation practices listed in food establishment under investigation, but there was no documented could be used as references to determine the hygienic conditions of workers in plant under investigation. Therefore it should be suggested that, record keeping of the results of personal hygiene are very important and could be used as verifying tool for the prerequisite programs of FSMS.

Preliminary Hazard Analysis: Before the preliminary hazard analysis of wheat milling processing line could be described, the food product, its distribution and intended use should be established by developing a complete description of the food product (wheat flour), such as the composition, chemical, biological and physical characteristics, the undergone treatments, packaging, durability, storage conditions and distribution methods. The description concerns raw materials (wheat grains) as well as finished products (wheat flour) [6].

Developing processing flow diagrams was very important step for implementation of FSMS in milling processing line under investigation. A flow diagram concerning flour manufacturing (as shown in Fig. 1) presents the manufacturing general diagram from the reception of the raw material until expedition of the finished products and could be summarized as follows. Flour milling begins with cleaning and scoring of wheat grains to separate and remove non-wheat material. Wheat is stored under dry conditions (usually 8-12% moisture, a_w between 0.40 and 0.65) to prevent development of fungal growth. Such dry wheat is not suitable for milling as it is too brittle. After initial cleaning, before wheat enters the mill, water is added, usually by means of a fine spray, to increase the moisture content of the wheat to 14-15%, (a_w0.68-0.70) in manufacturing step recognized as conditioning. The amount of water is carefully calculated from the initial moisture content of the wheat. This increases the plasticity of the outer bran layer of the grain, preventing it from fracturing during milling and ensuring easier separation from the endosperm (flour) later in the milling process. To ensure even penetration of water into the bran layer, conditioned wheat is held in large conditioning bins, usually overnight, but sometimes for up to 24-36 h, depending on wheat type and initial moisture content. During milling, grains are broken open and undergo a sequence of reduction, grinding and sifting operations to separate endosperm from outer grain layers. Inner endosperm fractions are ground to produce semolina and then flour. Outer grain layers comprising bran, wheat germ and pollard are removed by sifting. These operations create a considerable amount of heat, so that moisture condensation in the break rolls, reduction

rolls and sifters can sometimes lead to buildup of flour residues inside equipment. Microorganisms, particularly fungi, may become established in these moister residues, causing contamination of the mill products.

Conducting a Hazard Analysis: Hazard analysis is ready to be conducted now as the flow diagram has been developed and verified. To facilitate this task, hazard analysis was conducted step by step from the reception of the raw material (wheat grains) to the finished products (wheat flour). Hazard analysis aims to identify at each step what could actually go wrong and result in food being unsafe to consume. Hazards are categorized into three general areas: biological (pathogens), chemical (toxic substances and pesticide residual) and physical (foreign bodies). Table 6 illustrates the results of hazard analysis of raw materials and different milling steps of wheat milling plant under investigation. According to the already-identified hazards, several preventive measures such as visual inspections, supervision, correct cleaning and maintenance and good personal hygiene were conducted in the company. After conducting the Hazard Analysis of wheat grains and different milling steps, microbiological analysis of wheat grains was made for identification of different microbiological hazards that could be affecting the safety of final product, (wheat flour).

Results of microbiological analysis are shown in Table 7, It could be noticed that, wheat grains contained microbiological load with little differences according to the season of investigation. Therefore, wheat grains tested during autumn contained 4.85, 2.72, 2.10, 1.89 and 4.69 log cfu/g for total plate count and counts of Moulds, aerobic & anaerobic spore forming bacteria and coliform group, respectively. At the same time, tested wheat grains during spring season have a microbiological load of 4.84, 2.73, 1.89, 1.36 and 4.74 log cfu/g for the same aforementioned microbiological criteria, respectively. On the other hand, count of yeast and E. coli were being at the minimum level of detection during different investigation periods as listed in the same table. Concerning the results of analysis wheat grains for the presence of pathogenic bacteria e.g. *B. cereus* and *S. aureus* it could be noticed that these criteria were being at the minimum level of detection during different investigation periods, (un-tabulated data). At the same time, *Salmonella sp*. was not detected at any period of investigation. Wheat quality is of high importance to flour quality. A comparison of the milling of high and low microbiological quality wheat and their respective end product flour showed that wheat of low microbiological quality yields flour with high microbial loads as reported by Berghofer *et al.* [3].

During different investigation periods (autumn and spring) wheat flour has been produced from milling processing line under investigation were microbiologically analyzed and the results were tabulated in Table 8. It could be noticed that wheat flour, after different milling steps as illustrated in Fig. 1 had a microbiological load of 4.30, 3.63, 2.10, 1.58 and 2.53 log cfu/g for total platee count and counts of Moulds, aerobic & anaerobic spore forming bacteria and coliform group, respectively during autumn seasons. The microbiological load of tested wheat flour for the aforementioned microbiological criteria were 4.17, 2.45, 1.89, 1.22 and 1.80 log cfu/g, respectively during the spring seasons. The variation in microbiological load of wheat flour in comparison to wheat grains as noticed in Tables 7 and 8 showed that wheat flour had generally microbiological load lower than wheat grains especially anaerobic spore forming bacteria and coliform group, which could be attributed to the effect of milling steps such as cleaning and hydration steps on reduction of the microbiological load of grains. These results could be correlated to the results of the presences pathogenic bacteria *B. cereus*, *S. aureus* and *Escherichia coli* as the results of these criteria were being at the minimum

Table 5: Wheat flour description and its intended use

Product name	Wheat flour
Product characteristics	Wheat flour is the product prepared from grain of common wheat, Triticum aestivum L., or club wheat, Triticum compactum Host or mixtures thereof, by grinding or milling processes in which the bran and germ are partly removed and the remainder is comminuted to a suitable degree of fineness [32].
Intended use	In powder form production bakery products e.g. Bread ; pan bread ; Pasta; Biscuit
Packaging	handle in woven plastic bags
Shelf-life	(9 Months) [33].
Where the product will be sold	Supermarkets
Special distribution control	No physical damage, excess humidity or temperature extremes.
Labeling instructions	Required to ensure product safety, e.g.net weight; flour type; additives if any ;trade mark

Table 6: Hazard analysis of wheat milling processing steps

Processing step	HazardBiological (B) Physical (P) Chemical (C)	Control measuring	Verification
Receiving In site	Contamination from the supplier and shipping • Moulds and insects (B) • Exotic materials and metals (P) • Heavy metals(C) • Pesticide Residues (C) • Insect injury (B)	• Supplier MSDS • Lab inspection	• Verify of MSDS & Buying from certified suppliers • Visual inspection before receiving
Storage in Silos	Contamination during storage conditions • Fungal infection and insect (B) • Pathogenic bacteria (B)	Lab inspection& 3rd party lab	• Fumigation for silos • Re-aeration
Preparation for milling (Get rid of impurities and insects in wheat)	• Impurities and exotic metals (P) • Insects(B)	Lab inspection	Re-sieving & maintenance for sieve
Hydration	water used in Hydration • Microbial infection(B) • Heavy metals from (P)	3rd party lab	Verification for water safety
Milling (smoothing and sieving)	• Foreign Impurities(P)	Lab inspection	Re-sieving & maintenance for sieve
Packaging	• Harmful substances from packaging material (C)	Purchases officer	• Verify of MSDS & Buying from certified suppliersVisual inspection before receiving
Caching and transporting the product	• Infection with Fungal or insect (B) • Oxidation (C)	3rd party lab and Lab inspection	• Verify of good aeration • Visual inspection for trucks

Table 7: Microbiological analysis of wheat grains during different investigation seasons

	Microbiological analysis (log_{10} cfu/g)						
Investigation seasons	Total plate count	Count of Yeast	Count of Moulds	Aerobic spore forming bacteria	Anaerobic spore forming bacteria	Coliform group	Escherichia coli.
Autumn	4.85 ± 0.01	<1	2.72 ± 0.1	2.10± 0.03	1.89 ± 0.07	4.69 ± 0.03	<1
Spring	4.84± 0.01	<1	2.73 ± 0.01	1.98 ± 0.07	1.36 ± 0.16	4.27 ± 0.04	<1

±: standard deviation

<1: viable colony was not detected at detection limit < 10^1 cfu/g

Table 8: Microbiological analysis of wheat flour during different investigation seasons

	Microbiological analysis (log_{10} cfu/g)						
Investigation seasons	Total plate count	Count of Yeast	Count of Moulds	Aerobic spore forming bacteria	Anaerobic spore forming bacteria	Coliform group	Escherichia coli.
Autumn	4.30 ± 0.02	<1	3.63± 0.04	2.10 ± 0.04	1.58 ± 0.2	2.53 ± 0.05	<1
Spring	4.17 ± 0.05	<1	2.45 ± 0.07	1.98 ± 0.12	1.22 ± 0.18	1.80 ± 0.1	<1

± :standard deviation

<1: viable colony was not detected at detection limit < 10^1 cfu/g

Table (8a): Microbiological analysis of wheat bran during different investigation seasons

	Microbiological analysis (log_{10} cfu/g)						
Investigation seasons	Total plate count	Count of Yeast	Count of Moulds	Aerobic spore forming bacteria	Anaerobic spore forming bacteria	Coliform group	Escherichia coli.
Autumn	5.51 ± 0.02	<1	3.34 ± 0.03	2.09± 0.10	1.89 ± 0.07	4.60 ± 0.03	<1
Spring	5.25 ± 0.02	<1	3.09 ± 0.01	2.04 ± 0.07	<1	4.16 ± 0.03	<1

± :standard deviation

<1: viable colony was not detected at detection limit < 10^1 cfu/g

Table 9: HACCP worksheet of investigated wheat milling plan

Processing step	Hazard Biological (B) Physical (P) Chemical ©	Control measuring Target	Acceptable limit	Critical limit	Measurement criteria Who	When	How	Corrective action
Receiving In site	Moulds and insects(B)	absent	1 bugs/kg	2 bugs/kg	lab	per lot	visual inspection	--
	Exotic materials and metals (P)	absent	3%	5%	lab		visual inspection	Re-screening process and repair screens and magnets (metal detectors)
	Heavy metals(C)	absent	0.5 ppm	1 ppm	external lab		Atomic absorption	lot rejected
	Pesticide Residues(C)	absent	absent	positive	external lab		Multi residual analysis	lot rejected
	Insect injury (B) during transportation	absent	1 bugs/kg	2 bugs/kg	lab		visual inspection	Re-screening process and repair screens and magnets (metal detectors)
Storage in Silos	Contamination during storage conditions	--	--	--	--	per shift	--	--
	Fungal infection and insect(B)	absent	1 bugs/kg	2 bugs/kg	lab		visual inspection	lot rejected
	Pathogenic bacteria (B)	absent	absent	absent	external lab		iso test methods	lot rejected
Preparation for milling	Impurities and exotic metals(P)	absent	0.10%	0.20%	external lab	monthly	visual inspection	Re-screening process and repair screens and magnets (metal detectors)
	Brocken	absent	0.60%	1.00%		monthly	visual inspection	
	Insects(B)	absent	1 bugs/kg	2 bugs/kg	lab	per shift	visual inspection	
Hydration	water used in Hydration	--	--	--	--	--	--	--
	Microbial infection(B) (coliform and E coli)	<1	<1	<1	external lab	monthly	iso test methods	lot rejected
	Heavy metals from (P) (Fe) &(Mn)	absent	0.3 ppm &0.1 ppm	0.5 ppm	external lab	monthly	Atomic absorption	lot rejected
	foreign Impurities(P)	absent	300 ppm	500 ppm	lab	per shift	Atomic absorption	lot rejected
Milling (smoothing and sieving)	residual from milling (B)	absent	0.40%	0.50%	lab	per shift	Atomic absorption	lot rejected
	metals particles (p)	absent	0.01%		lab	per shift	Atomic absorption	lot rejected
	residual insects(B)	absent	1 bugs/kg	2 bugs/kg	lab	per shift	visual inspection	Re-screening process and repair screens and magnets (metal detectors)
Packaging	Harmful substances from packaging material (C)	absent	absent	absent	MSDS from supplier	per lot	MSDS from suppliers	lot rejected
product transporting	infection with Fungal or insect(B)	ABSENT	Positive	Positive	lab	per shift	visual inspection	Re-screening process and repair screens and magnets (metal detectors)
	oxidation (C)(Fe)	absent	0.3 ppm	0.5 ppm	supplier MSDS and lab		per lot	supplier MSDS and lab

level of detection during different investigation periods, (un-tabulated data). On the same time, *Salmonella sp*. was not detected at any period of investigation. In the same time, as wheat grain layers are separated during milling process, major surface-adhering contaminants especially microbial germs are concentrated in bran, wheat germ and pollard, which comprise the outer layers of the grain. Consequently, the inner endosperm fraction contains lower microbial counts and flour is the cleanest end product of the milling process. The lower microbiological counts of produced flour at the end of milling process indicate that equipment contamination may not contribute to microbiological contamination; and had been indicated the effect of sanitary programs in the milling line. In the same time, the microbiological quality of incoming wheat has a strong influence on the ultimate quality of milling end products. These results could be correlated with the results of microbiological analysis of bran during different investigation periods as shown in Table 9. From these results it could be noticed that, microbial load of produced wheat bran was 5.51, 3.34, 2.09 and 1.89 $\log_{10}$ cfu/g for tested microbiological parameters of total plate count and counts of Moulds, aerobic & anaerobic spore forming bacteria, respectively during autumn seasons. The microbiological load of tested wheat bran during the spring seasons for the aforementioned

microbiological criteria were 5.25, 3.09, 2.04 and <1log cfu/g, respectively. With respect to coliform group, wheat bran had a higher load in comparison to wheat flour as it recorded 4.06 and 4.16 log cfu/g during investigation periods as autumn and spring seasons, respectively. The results of the presences pathogenic bacteria *B. cereus*, *S. aureus*, *Escherichia coli* and *Salmonella* sp. of tested wheat bran have the same trend observed for tested wheat flour during different investigation periods as these pathogeneses were being at the minimum level of detection during different investigation periods, (un tabulated data).

Identifying Critical Control Points: Critical Control Point (CCP) refers to a step, or procedure in a food process at which an essential control measure can be applied to eliminate, prevent or reduce an identified food hazard to an acceptable limit [6]. Each CCP has one or more critical limits to ensure that hazards are prevented, eliminated and reduced to acceptable levels. During a flow diagram's checking procedure using the decision tree, several critical control points have been set up: the survival of cereal insects during wheat storage operation, the presence of foreign bodies during cleaning, the proliferation of moulds during moistening, the proliferation of moulds and insects during transfer and storage of finished products and finally the presence of foreign bodies during packaging.

Setting the Critical Limits for Critical Control Points: The critical limits must be established to guarantee that the acceptable level identified for each hazard at each CCP is not exceeded. During CCP identification, establish critical limits should be measurable where it could be reasonably demonstrated that the threshold level has not been exceeded.

Establishing Monitoring Procedures for the Critical Control Points: Planned observations and measurements are conducted to assess whether a CCP is under control and produce an accurate record for a future verification process.

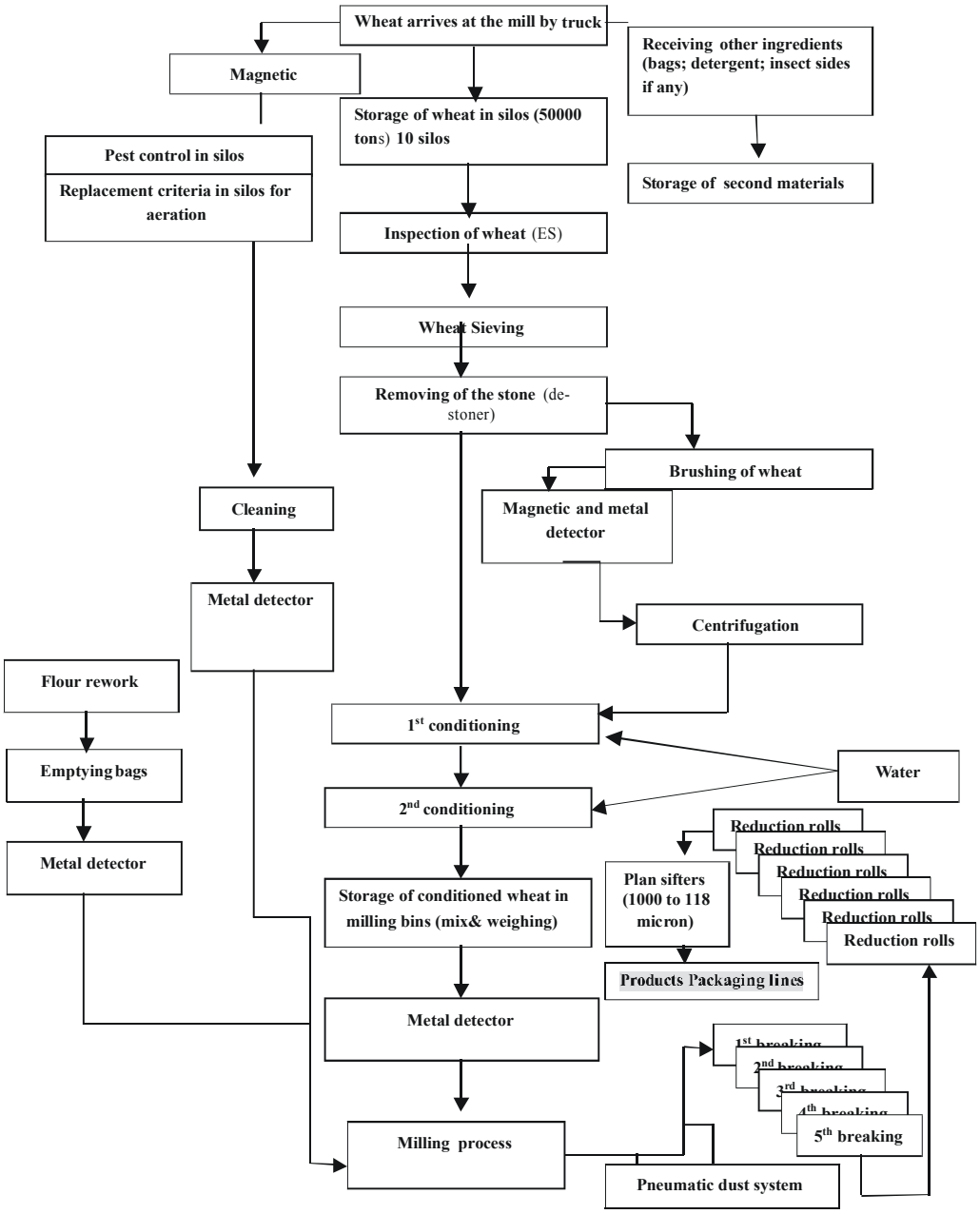
Establishing a Corrective Action: During investigation of milling processing line some specific corrective actions were established for each identified CCP. These corrective actions are performed when the monitoring procedures indicate that, the critical limits are exceeded. The corrective actions were designed to rapidly regain control over the CCP and prevent recurrence.

Establishing Verification Procedures: Validation, verification and review of established HACCP plan were established during the investigation of milling plan. The verification procedures were established in order to check if the HACCP system is working as HACCP plan. This could be done by establishing accurate records of the previous and ongoing measurements as well as the tracking of those products that have exceeded the critical limits. The different aforementioned principles of designed HACCP plan during the investigation of milling processing plant are presented in Table 9.

CONCLUSION

The implementation of Food Safety Management system according to the standard ISO 22000 in food-processing industry allows controlling of different hazards affecting the health of consumers. The ISO 22000 is the standard which harmonizes the practices of management and the HACCP principles. It guarantees food safety to industrialists, distributors and customers. Furthermore, it specifies essential requirements to ensure food safety at all levels: the prerequisite programs (PRPs) and the HACCP plan. In this paper, Food Safety Management system was developed during the milling processing line of wheat grains for controlling of microbiological hazards during milling process. Various microbiological methods of analysis and procedures have been developed to monitor the safety of wheat grains at an early stage and during milling processing line. The PRPs implementation allowed us to master the likelihood of incidence of physical, chemical and microbiological hazards. The HACCP plan principles were established and have been enabled to monitor and control of identified microbiological hazards. The ISO 22000 specifies the requirements needed for a system that can monitor and master hazards and ensure that food is safe for human consumption. However, its application requires an understanding of the prerequisite programs and the HACCP principles as well as the procedures to be implemented.

Appendix
Flour processing flowchart



REFERENCES

1. FAO, 2012. FAO World Food Situation and Food Outlook Reports; http://www. fao. org/ world food situation / wfs-home/en/
2. Wade, P., 1988. Biscuits, Cookies and Crackers, Vol. 1: 1-45 and 116-140. Elsevier Applied Science: London and New York, U.S.A.
3. Berghofer, L.K., A.D. Hocking, Di Miskelly and E. Jansson, 2003. International Journal of Food Microbiology, 85: 137-149.
4. Eyles, M.J., R. Moss and A.D. Hocking, 1989. The microbiological statues of Australian flour and the effect of milling procedures on micro flora of wheat flour. Food Aust., 41: 704-8.

5. Hesseltine, C.W. and R.R. Graves, 1966. Microbiological research on what and flour. Econ. Bot., 20: 156.
6. ISO 22000, 2005. Food safety management systems requirements for any organization in the food chain.
7. ISO/TS 22004, 2005. Food safety management systems e Guidance on the application of ISO 22000
8. Manivisharma, S.K., 2002. Biofilms evaluation as an essential component of HACCP for food/dairy processing industry a case. Journal of Food Control, 13: 469- 477.
9. Mortimore, S., 2001. How to make HACCP really work in practice. Food Control, 12: 209-215.
10. Norton, C., 1992. Preparing your operation for the HACCP process. Food Management, 275: 64.
11. Sperber, W.H., K.E. Stevenson, D. Bernard, T. Deibel, K.E.Moberg, L.J.Walker, 2003. Hazard analysis critical control point and prerequisite program implementation in small and medium size food business. Food Control, 14: 169-174
12. Wallace, C. and T. Williams, 2001. Pre-requisites: A help or a hindrance to HACCP. Food Control, 12: 235-240.
13. William, H., 2005. HACCP and Transparency. Food Control, 16: 505-509.
14. Gaaloul, I., R. Samira and E.G. Raoudha, 2011. Implementation of ISO 22000 in cereal food industry "SMID" in Tunisia. Food Control, 22: 59-66.
15. ES: 1251-2, 2005. wheat flour with its different extraction and methods of analysis and testing part 2: method of analysis and testing - sampling
16. Stinson, G.G. and N.P. Tiwari, 1978. Evaluation of quick bacterial count methods for assessment of food plant sanitation. J. Food Prot., 41: 269-271.
17. AOAC, 2000. Official method of analysis. 17th Ed. (Ed. W. Horwitz) AOAC, Gaithersburg. MD
18. ISO 4833, 2003. Microbiology of food and animal feeding stuffs -- Horizontal method for the enumeration of microorganisms -- Colony-count technique at 30 degrees C
19. ISO 4832, 2006. Microbiology of food and animal feeding stuffs - Horizontal method for the enumeration of coliforms - Colony-count technique.
20. ISO 6888-1(1999 Amend 2003) Microbiology of food and animal feeding stuffs - Horizontal method for the enumeration of coagulase-positive staphylococci (*Staphylococcus aureus* and other species) - Part 1: Technique using Baird-Parker agar medium
21. SMWW, 1998. Standard Methods for the Examination of Water and Wastewater. 20th Edition Chap. 9
22. ISO 6579, 2002. Microbiology of food and animal feeding stuffs - Horizontal method for the detection of *Salmonella* spp.
23. ISO 21527, 2008. Microbiology of food and animal feeding stuffs - Horizontal method for the enumeration of yeasts and moulds - Part 2: Colony count technique in products with water activity less than or equal to 0, 95.
24. APHA, 2001. Compendium of Methods for the Microbiological Examination of Foods. 4th Ed., American Public Health Association, Washington, D.C.
25. ISO7932, 2004. Microbiology of food and animal feeding stuffs - Horizontal method for the enumeration of presumptive *Bacillus cereus* - Colony-count technique at 30 degrees C
26. ISO 18593, 2004. Microbiology of food and animal feeding stuffs - Horizontal methods for sampling techniques from surfaces using contact plates and swabs.
27. ES: 3393,2005.Egyption standard, general principles of food hygiene for establishment of food products.
28. ES: 3856, 2006. Egyptian standard Recommended Egyptian code of practice; general principles of food hygiene.
29. CAC/RCP1-1969 (Rev.4-2003)Codex Alimentarius recommended international code of practice general principles of food hygiene
30. ES 190, 2007. Egyptian standard for drinking water.
31. Kanbakna, U., A.H. Con and A. Ayar, 2004. Determination of microbiological contamination sources during ice cream production in Denizli. Turkey. Food Control. 15: 463-470.
32. CODEX STAN 152.,1985)Codex standard for wheat flour (Rev. 1 - 1995)
33. ES 2613-1, 2006. Egyptian standard, shelf life for food production.