Application of Hazard Analysis Critical Control Points in Dairy Products: A Case Study of Probiotic Talbina

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Abstract: Probiotic Talbina (Pro-Talbina) is a new traditional dairy product prepared by cooking barley flour with milk and adding probiotic cultures. Usually such products are not produced under sanitary conditions and are most probably evolved in the home through trial and error. Nowadays, traditional foods are produced both at home and at the commercial level, in small and large amounts. Therefore, the implementation of Hazard Analysis Critical Control Point (HACCP) system is regarded as a developing system for food hygiene and safety, and monitoring to confirm and ensure food safety. Thus, the aim of this study is to identify and establish critical control points (CCPs) and determine a HACCP plan for the production of Pro-Talbina. The study revealed that CCPs for Pro-Talbina production were raw milk, pasteurization, barley flour, probiotic bacteria, filling containers and storage. The safety of the final product is dependent on the prevention of biological (i.e. pathogenic bacteria and moulds), chemical (i.e. mycotoxins, heavy metals, pesticides, and antibiotic residues) and physical hazards. The use of probiotic bacteria cultures (*Lactobacillus gasseri*, and *Lactobacillus reuteri*) enhanced and controlled the risk of hazards that may be present. In conclusion, this study revealed the importance of HACCP for producing safe and good quality Pro-Talbina as well as to ensure marketing and safe human consumption of the products.
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1. Introduction

The HACCP system is currently regarded as the best preventive system for managing food safety (Hatakka, 2000). However, its success and effectiveness in preventing food borne diseases and risks to consumer health depend on the correct application of its principles, combined with other programs, which include safety infrastructure and the programs ‘‘good manufacturing practice’’ and ‘‘sanitation standard operational procedures’’ (GMP/SSOP) (Azanza, 2006). These principles require an investment in staff training, structural changes and new equipments as reported by Panisello and Quantick (2001). Corlett (1998) added that HACCP is internationally acknowledged as the system of choice to ensure food safety because it is logical and practical, preventive in nature, and places the responsibility of ensuring food safety in the hands of all parties concerned.

The Joint FAO/WHO Food Standards Program (CAC, 1997) was one of the first international bodies to adopt the HACCP system and promote its application. For food to be acceptable, it has to be suitable and safe. Suitability usually refers to the sensory, nutritional and convenience aspects of foods, whereas safety is “the assurance that food will not cause harm to the consumer when it is prepared and/or eaten according to its intended use” (CAC, 2003). Until recently, the major measures used for protection of food were control of temperature and proper protection of food in a clean manner. Although these measures are still essential, it is apparent that these methods are unable to eliminate food safety problems (Henroid and Sneed, 2004; Jones, 2004). It is now widely known that traditional approaches, such as product testing, inspection, and knowledge based training provision do not provide the necessary control to cope with modern hazards (Eves and Dervisi, 2005).

Talbina is considered as an ancient traditional food, and the prophet Mohamed recommended it for its nourishing benefits for seven diseases (Hadith), these include grief, high cholesterol levels, heart disease and hypertension. It could be very nutritious, beneficial in coughs and inflammation of the stomach and it has the ability to expel toxins from the body and act as a good diuretic (Ibn Khaldun, 1867). In the preparation of most traditional foods, there are no control measures to destroy un-wanted microorganisms prior to consumption, and in some of these foods, raw materials affect the safety of the end product. Several investigators reported that barley grains and flours (the first composite in Talbina) are contaminated by high frequencies of *Fusarium* and *Aspergillus* species (Baliukoniene *et al*., 2003; Maenetje and Dutton, 2007). Meanwhile Haubruge *et al*. (2003) reported that ninety-six percent of barley samples were contaminated with zearalenone and seventy-six percent of the samples were contaminated with T-2

toxin, whereas Teuber (1992) reported that a high number of pathogens contaminate raw milk (the second composite in Talbina). Some of them (*Staphylococcus aureus*, *Salmonella typhimurium*, *Listeria monocytogenes*, *Bacillus cereus*, *Escherichia coli* and *Yersinia enterocolitica*), can be transferred from milk to the final product thus causing food poisoning (Skovgaard, 1990). It was also reported that some of the toxic metabolites such as aflatoxins (Nemati *et al*., 2010), antibiotic residues (Kwang-Geun *et al*., 2009) and pesticides (Salem *et al*., 2009) are present in milk.

Some lactic acid bacteria (LAB) strains have been used as probiotics due to their resistance to host gastrointestinal conditions, adhesion to host intestinal epithelium and the prevention of the growth or invasion of pathogenic bacteria into the animal intestine (Chiu *et al.*, 2007). The most important LAB species are of the genera *Lactobacillus* and *Bifidobacterium*, which are involved in food microbiology and human nutrition, due to their role in food and feed production and preservation, and also to the probiotic properties exhibited by some strains (Felis and Dellaglio, 2007). Multiple reports have described the health benefits of probiotic bacteria on gastrointestinal infections, improvement in lactose metabolism, reduction in serum cholesterol, immune system stimulation, antimutagenic properties, anti-carcinogenic properties, anti-diarrheal properties, improvement in inflammatory bowel disease and suppression of *Helicobacter pylori* infection by addition of selected strains to food products (Nomoto, 2005; Shah, 2007). Many different species and strains of LAB have been tested for the removal of aflatoxins (AFs) and other mycotoxins from aqueous solution and food model. It has been shown earlier by El-Nezami *et al.* (2000) that LAB detoxify aflatoxin B_1 (AFB_1), which is the most potent known human carcinogen. Binding effects with other fungal toxins such as zearalenone, trichothecenes and fumonisins, have been also observed in chemical analytical investigations (El-Nezami *et al*., 2002a, 2002b; Niderkorn *et al*., 2006). Recently in our previous work, *Lb. gasseri*, *Lb. reuteri* and commercial yoghurt starter bacteria were added to Talbina to produce Pro-Talbina with long shelf life (Hathout and Aly, 2010). Therefore, the aim of this study is to identify and establish critical control points (CCPs) and implement HACCP during the production of Pro-Talbina. This research can be considered as one of the first application on this product.

2. Application of HACCP system during Pro-Talbina production

HACCP is a systematic approach to the identification, assessment, and control of hazards. The approaches and guideline adopted and safety recommendations made by the International Commission on Microbiological Specifications for Food (ICMSF, 1988), the National Advisory Committee on Microbiological Criteria for Foods in the United States (NACMCF, 1992), the International Life Science Institute (ILSI, 1993), and Codex Alimentarius Commission (CAC, 1993) have been described. This logical approach to food safety has been summarized in the seven principles of the HACCP system (Table 1). Among the prerequisites for HACCP system, application, training and implementing Codex general principles of food hygiene or Food and Drug Administration (FDA) good manufacturing practices (GMPs) are considered essential.

2.1. Product description

Pro-Talbina is prepared by cooking barley flour (10%) and milk and then adding probiotic bacteria (>10^7 CFU/g) to the mixture (Table 2), and has a sour and acidic taste. The nutritional quality of Talbina is dependent on milk, (which is a complete food especially for children), and barley, (which is an excellent source of B-complex vitamins, minerals, β-glucan, and a number of antioxidants).

2.2. Flow diagram

The flow chart of Pro-Talbina is described in Figure 1. The order and relations of all steps of Pro-Talbina production including ingredients, intermediate and end products as well as the CCP are shown to obtain a final product with appropriate standards.

2.3. Determination of CCPs in Pro-Talbina – Decision tree

The decision tree (Table 3) is a tool used to determine CCP for each processing stage (Bolat, 2002; ILSI, 2004), and it is considered as an independent scientific process taken to control and manage the risks.

2.4. Critical Control Points

A Critical Control Point (CCP) is designed to obtain a final product with appropriate standards. Six CCPs were recorded during the production of Pro-Tablina (Table 4) and will be discussed as follows:

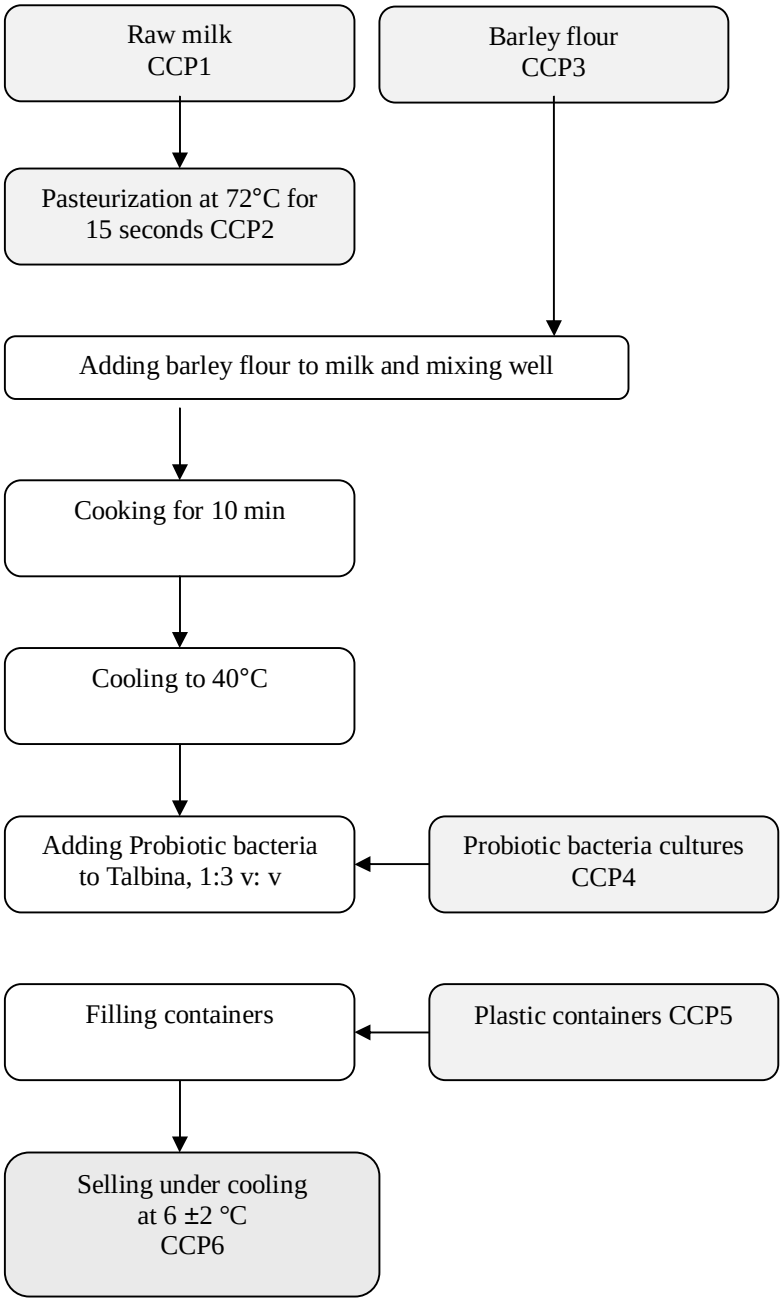

Figure 1. Process Flow Chart for Pro-Talbina

Table 1. The HACCP Principles

Principle 1	Conduct a hazard analysis
Principle 2	Determine the Critical Control Points (CCPs)
Principle 3	Establish critical limit(s)
Principle 4	Establish a system to monitor control of the CCP
Principle 5	Establish the corrective action to be taken when monitoring indicates that a particular CCP is not under control
Principle 6	Establish procedures for verification to confirm that the HACCP system is working effectively
Principle 7	Establish documentation concerning all procedures and records appropriate to these principles and their application

Table 2. Product description of Pro-Talbina

Name of product	Pro-Talbina
Important product characteristics	Probiotic bacteria > 10^7, Barley flour 10%, pH between 4.70 – 5.44, no preservatives used
Intended use	Pro-Talbina s prepared for immediate consumption. Consumed by general public
Shelf life	up to 21 days < 6°C
Packing	Plastic containers press to seal
Special distribution control	Transport, store, and display refrigerated (below 6ºC) under hygienic conditions

2.4.1. Raw milk (CCP1)

Many hazards can be found in raw milk. These include biological hazards (pathogenic microorganisms), chemical hazards (antibiotics residues, pesticide residues and mycotoxins) and physical hazards (foreign material) (Cullor, 1997). Several surveys have detected pathogenic microorganisms in milk, including *Campylobacter jejuni*, Shiga-toxin producing *E. coli* (STEC), *L. monocytogenes*, *Salmonella* spp., and *Yersinia enterocolitica* (Table 5). Some of these pathogenic microorganisms have habitats in food-producing animals, such as skin and gastrointestinal tracts, and in the farm environment (Oliver *et al*., 2005). These pathogens can enter meat and milk products during slaughter and milking (McEwen and Fedorka-Cray, 2002). In recent years, bacteria from four genera, *Campylobacter* spp., *Salmonella* spp., *E. coli* and *L. monocytogenes*, are the organisms that have been associated most frequently with food borne illness outbreaks (Yilmaz *et al*., 2009).

Exposure of animals to AFB_1 occurs mainly by the ingestion of contaminated feeds (Hagler and Whitlow, 2007). In the liver, ingested AFB_1 is bio-transformed by the hepatic microsomal cytochrome P450 into aflatoxin M_1 (AFM_1), which is then excreted into the milk of lactating animals (Battacone *et al*., 2003; Gallo *et al*., 2008). In dairy cows, the amount of AFM_1 excreted into milk (Table 6) can be up to 3% of the AFB_1 intake and is affected by milk yield (Masoero *et al*., 2007). The consumption of milk and milk products by human populations particularly by infants and young children is quite high, thereby increasing the risk of exposure to AFM_1 (Rastogi *et al*., 2004), and is considered responsible for the appearance of some cancers (Cullen *et al*., 1987). On the other hand, organochlorine pesticides, heavy metals and antibiotic residues contaminating milk (Table 6) are considered the main dangerous aspects (Darko and Acquaah, 2008; Fontcuberta *et al*., 2008; McEwen and McNab, 1997; Nisha, 2008). The presence of antibiotics residues can have an inhibitory effect on the probiotic bacteria activity, which can affect the quality of the final product.

2.4.2. Pasteurization (CCP2)

Pasteurization is a very important step in dairy products and aims at limiting public health hazards arising from pathogenic microorganisms, destroys all pathogens of concern in raw milk, and extends the keeping quality of products by reducing the number of spoilage microorganisms derived from raw milk (Jervis, 1992; Arvanitoyannis and Mavropoulos, 2000). In a High Temperature Short Time (HTST) the minimum temperature – time conditions are 72°C for 15s. The pasteurization efficiency should be controlled by establishing management procedures, including maintenance of correct temperature and holding time (Azar and Nejad, 2009). Cross-contamination of milk after pasteurization is of major importance and has to be avoided (Varnam and Sutherland, 1994), as the main contamination sources are air, water, equipment, people, utensils, cultures and packaging.

2.4.3. Barley flour (CCP3)

The examination of barley samples obtained from East Slovakia confirmed the occurrence of *Penicillium* spp. (75% samples), *Alternaria* spp. (66.7% samples) and *Cladosporium* spp. (58.3% samples) (Čonková *et al*., 2006). Under warm

climatic conditions, the contamination of barley grains and flour with fungi that are capable of producing mycotoxins is very important (Chasseur *et al*., 1997). Surveys of barley samples collected from European countries revealed that deoxynivalenol (DON) was the major toxin (Müller and Schwadorf 1993), the dominance of zearalenone was observed in grains collected in Tibet (Table 7) (Haubruge *et al*., 2003). Among barley samples collected in the Netherlands, 83% and 100% were contaminated with DON and zearalenone, respectively (Tanaka *et al*., 1990). Barley flour can also be contaminated by one or more mycotoxins during milling.

2.4.4. Probiotic bacteria (CCP4)

In the Pro-Talbina production, the following probiotic bacteria *(Lb. gasseri* LA39*, Lb. reuteri* LA6) were added separately. The purity of the cultures is considered an important step (CCP) since the contamination of these cultures with bacteriophage may negatively affect the quality of the final product leading to slow acid production from LAB and to higher moisture content (Mullan, 1986).

2.4.5. Filling containers (CCP5)

Filling containers are considered a CCP because any damage in them or the presence of toxic residuals may lead to the contamination of the final product.

2.4.6. Storage (CCP6)

Storage during shelf life at 6±2°C is important, since at higher temperatures products may be contaminated by different fungal species and/or pathogenic microorganisms.

3. Discussion

Control measures for raw milk include milk acidity, standard plate count, somatic cell count, storage temperature and freezing point (Table 8). Thus, milk containing any undesirable substances should be rejected, since their existence in milk may have a direct and/or an indirect effect upon the quality of the final product. Sinniah *et al.* (2010) reported that total bacterial count should be below the internationally recommended levels (10^5 CFU/mL). On the other hand, any extraneous matters should be removed by filtration, and these filters must be frequently changed because they can be covered with sediment, which can act as milk contaminant. Meanwhile, strict hygienic conditions and appropriate cleaning of milk containers must be adopted. Duration of cleaning, temperature and concentration of disinfectants are considered control measures.

On the other hand, barley flour should be examined to make sure it does not contain any moths or worms, or any other insects or even blight of other pests. Microbiological analysis should be undertaken to determine total fungal count and to select the cleanest sample for Talbina manufacture. The storage temperature for barley flour must be less than 20°C with a relative humidity with less than 65%. For long storage period, microbiological analysis should be carried out.

Concerning the addition of probiotic culture to Talbina, experienced personnel adhering to strict hygienic rules should supervise the culture addition. The activity of culture must be checked before use, since any changes in activity may be due to either an increase in bacteriophage in milk or the presence of inhibitory substances. The prepared cultures must be used within 24 h, as extended storage time is considered a high risk factor for hazards, and the microbial cross contamination must be controlled.

On the other hand, the stock culture must be maintained under appropriate conditions and checked periodically for strain identity and probiotic properties (FAO/WHO, 2001). Furthermore, viability and probiotic activity should be maintained throughout processing, handling and storage of the food product containing the probiotic, and verified at the end of shelf life (Hathout and Aly, 2010). Adequate quality assurance programs should be in place. Good manufacturing practices should be followed in the manufacture of probiotic foods. The Consultation recommends that the Codex General Principles of Food Hygiene and Guidelines for Application of HACCP (CAC, 1997) must be followed. To clarify the identity of a probiotic present in the food, the Consultation recommends that the microbial species be stated on the label. If a selection process has been undertaken at the strain level, the identity of the strain should also be included, since the probiotic effect seems to be strain specific. There is a need to accurately enumerate the probiotic bacteria in food products in order to include them on the label. The label should state the viable concentration of each probiotic present at the end of shelf life (Reid *et al*., 2001).

Equipment coming into contact with food must be designed and constructed to ensure that, where necessary, they can be adequately cleaned, disinfected and maintained to avoid the contamination of food. Tacker *et al*. (2002) reported that packaging materials must be obtained from certified suppliers in order to decrease microbial cross contamination, and should be inspected and stored separately from ingredients and final products.

Table 3. HACCP Decision Tree for Pro-Talbina Production

Process steps	Category hazard	Q1 Do preventive control measures exist? (Yes/No)	Q2 Is the step specifically designed to eliminate or reduce the likely occurrence of hazard to an acceptable level? (Yes/No)	Q3 Could contamination with identified hazard(s) or could this increase to unacceptable level? (Yes/No)	Q4 Will a subsequent step eliminate identified hazard(s) or reduce likely occurrence to acceptable levels? (Yes/No)	Is this step a CCP? (Yes/No)
1- Raw milk	**B:** Growth of pathogens	Yes	Yes	-	-	Yes
2- Pasteurization	**B:** Survival of pathogens	Yes	Yes	-	-	Yes
3- Barley flour	**P:** Foreign bodies	Yes	Yes	-	-	Yes
4-Probiotic bacteria preparation	**B:** Survival of pathogens **C:** Antibiotic and other inhibitors	Yes	Yes	-	-	Yes
5- Filling containers	**B:** Arrival of microorganism through air	Yes	No	Yes	No	Yes
6- Storage	**B:** Growth of pathogens	Yes	-	-	Yes	Yes

Table 4. HACCP Control Charts for Pro-Talbina Production

Process steps	Description of hazard	Possible control measures	Cont steps	Critical limits	Monitoring		Corrective actions
					Test	Frequency	
1- Raw Milk	**B:** Pathogen growth/ toxin production from time and temperature abuse	Store raw milk under refrigeration (2–5ºC)		Raw milk storage temp. < 7ºC and maximum storage period 72 hours	Storage temp. and time of every raw milk storage tank	Each batch	Discard affected batch and use UHT milk instead
	C: Antibiotic residue Aflatoxins	Antibiotic residue test and aflatoxin test	CCP1	Aflatoxin M_1<0.05 µg/kg	Aflatoxin test	Each batch	Discard contaminated batch
	P: foreign bodies, dust, straw	Removal of foreign bodies using cheese cloth		Absence of foreign bodies	Visual examination	Each batch	Re-Remove foreign bodies
2- Pasteurization	**B:** Pathogen growth	Pasteurization of milk at not less than 72°C for a holding time	CCP2	Pasteurization temperature not less than 72ºC for a holding time of not less than 15 seconds	Check temperature and time during heat treatment	Each batch	Discard affected batch Investigate, identify and correct cause of problem
3- Barley flour	**B:** Fungal contaminants	Store flour < 20ºC	CCP3	Low fungal count	Microbiological tests	Each batch	Discard contaminated batch
	C: Aflatoxin	Mycotoxin test		Mycotoxin < 20 µg/kg	Aflatoxin test	Each batch	Discard contaminated batch
	P: Insects, foreign bodies	Removal of foreign bodies using sieves with suitable mesh size, magnets and dust suction machine		Absence of foreign bodies	Visual examination	Each batch	Re-Remove foreign bodies

Table 4(Continued)

Process steps	Description of hazard	Possible control measures	Cont steps	Critical limits	Monitoring		Corrective actions
					Test	Frequency	
4-Probiotic bacteria preparation	**B:** Presence of bacteriophage and other microorganisms	Grown on specific media (MRS broth) for the prevention of other microorganisms growth Use of purified microorganisms cultures free of bacteriophage	CCP4	Free of contamination	Microscopic examination	Each batch	Check culture efficiency
5-Filling containers	**B:** Contamination by microorganisms and moulds	Washing the containers Proper rinsing after cleaning and disinfection	CCP6	Plastic cups clean and free from any food traces	Check cleaning and disinfection	Continuous	Re-cleaning and rinsing
6-Storage	**B:** Growth of moulds	Maintain cool storage at temperature < 6ºC	CCP7	Temperature ≤ 6ºC	Temperature measurement	Continuous	Adjust temperature
Manufacturing 1- Equipments	**B:** Growth of disease-causing microorganisms and moulds	Ensure cleanliness of equipments	GMP 1	Free from microbial contamination	Microbial examination	Continuous	Re-cleaning and rinsing
	C: Aluminum contamination	Do not use aluminum utensils or square container				At the time of purchasing the tools	Rejected
Manufacturing 2- Environmental	**B:** Airborne microorganisms	Cleaning and disinfection of the site to minimize airborne contamination	GMP 2	Free from airborne microorganisms	Evaluation for airborne microorganisms	Continuous	Re-clean and disinfection of workstation

CCP: Critical Control Point, GMP: Good Manufacturing Practice

Table 5. Microbiological Hazards in Raw Milk

Organisms	Prevalence rate (%)	References
Listeria monocytogenes	4.8	D'Amico *et al*., 2008
	1.2	Jayarao *et al*., 2006
	4.6	Jayarao and Henning, 2001
Campylobacter jejuni	2.2	Jayarao *et al*., 2006
	9.2	Jayarao and Henning, 2001
Salmonella spp.	11.0	Van Kessel *et al*., 2008
	6.0	Jayarao *et al*., 2006
Escherichia coli 0157:H7	0.23	Karns *et al*., 2007
Yersinia enterocolitica	6.1	Jayarao and Henning, 2001
Escherichia coli (Shiga toxin producer)	3.5	Cobbold *et al*., 2008
	3.9	Karns *et al*., 2007

Table 6. Chemical Hazards in Raw milk

Milk Contaminants	Contamination (%)	Range	Mean	MRLs	References
Mycotoxins (ngkg^{-1})					
AFM_1	94.5	0.007 – 115.93	-	50[a]	Mohammadian *et al*., 2010
AFM_1	-	-	98.9 0	50[a]	Rahimi, 2010
AFM_1	76.6	15.00 – 280	-	50[a]	Kamkar, 2005
AFM_1	90.9	2.00 – 83.0	-	50[a]	Lin *et al*., 2004
Pesticides (mgkg^{-1} fat basis)					
HCB	36.7	0.091 – 0.180	0.150	-	Abou Donia *et al*., 2010
Lindane	43.3	0.012 – 0.046	0.036	0.010[b]	Abou Donia *et al*., 2010
Aldrin	26.7	0.030 – 0.072	0.050	0.006[b]	Abou Donia *et al*., 2010
Heptachlor	10.0	0.016 – 0.030	0.022	0.006[b]	Abou Donia *et al*., 2010
p. p' DDT	16.7	0.022 – 0.048	0.032	0.020[b]	Abou Donia *et al*., 2010
Heavy metals (mgkg^{-1})					
Lead	-	6.60 – 8.2	-	0.02[c]	Anonymous, 2003
Antibiotic residues (µgl^{-1})					
Tetracycline	100	0.240 – 22.66	3.709	100[d]	Navratilova *et al*., 2009
Oxytetracycline	43.85	0.180 – 4.28	1.010	100[d]	Navratilova *et al*., 2009

MRLs: Maximum Residue limits

a: EC No 1881/2006 b: FAO/WHO (2008) c: CAC standard 230 (2001) d: CAC standard 02 (2009)

Table 7. Mycotoxin contamination of barley

Mycotoxins	Contamination (%)	Range (μgkg^{-1})	MRLs[a]	References
OTA	89.6	0.53 – 12.00		Gumus *et al*., 2004
OTA	52.0	0.00 – 0.046	5 μgkg^{-1}	Hawbruge *et al*., 2003
OTA	86.0	0.01 – 0.495		Wolf, 2000
OTA	31.0	0.10 – 2.700		Thelman and Weber, 1997
DON	62.5	0.00 – 530.0	750 μgkg^{-1}	Conkova *et al*., 2006
DON	12.0	0.00 – 0.200		Hawbruge *et al*., 2003
Zearalenone	96.0	0.00 – 0.270	75 μgkg^{-1}	Hawbruge *et al*., 2003
T2 toxin	76.0	0.00 – 0.163	-	Hawbruge *et al*., 2003

MRLs: Maximum Residue limits
a: EC No 1881/2006

Table 8. Standards for Raw Milk

Category	EC No 853/2004
Acidity (%)	0.16 - 0.17
Standard plate count (per mL)	≤ 100.000
Somatic cell count (per mL)	≤ 400.000
Temperature (°C)	≤ 6°C
Freezing point	-52 °C*

* Directive 92/46/EEC/1992

Filling containers design should provide adequate protection for products to minimize contamination, prevent damage, and accommodate proper labelling. These materials (equipments, filling containers) must be non-toxic and not pose a threat to the safety and suitability of food under the specified conditions of storage and use.

During storage, the product temperature is maintained at 6±2°C, in order to ensure the microbiological safety of this product and to prevent growth of undesirable and temperature related cross contamination. The control measures during storage include constant temperature and relative humidity ranging between 80-85% in refrigerated conditions. As well as enhancing the use by and sell by dates by adding to the package smart indicators such as Time Temperature Indicators (TTIs), which show through a visible color change whether the product is still fresh.

The evaluation of probiotic in food, as antimicrobial activity against potentially pathogenic microorganisms was one of the recommended attributes for potential probiotic strains (FAO/WHO, 2002). LAB exert a strong antagonistic activity against many food contaminating microorganisms as a result of the production of organic acids, hydrogen peroxide, diacetyl, inhibitory enzymes and bacteriocins (Hernandez *et al*., 2005). These LABs are used as food preservatives for directing or preventing the development of specific bacterial species, and fungi in some dairy and meat products (AbdAlla *et al*., 2008; Mohsen *et al*., 2009). In our previous work probiotic bacteria (*Lb. gasseri* and *Lb. reuteri*) were added as a new component to Talbina which increased the shelf life for over 21 days by delaying fungal growth (Hathout and Aly. 2010). This effect was due to the production of the bacteriocins gassericin A and reutericin 6 (Arakaw, 2009). Aly *et al*. (2009) also reported that cell free supernatants of *Lactobacillus* species caused inhibitory effect on *A. parasiticus* growth and aflatoxin production. On the other hand, Hathout and Aly (2009) revealed that *Lactobacillus* species bound and removed AFs from aqueous medium (in vitro). Other mycotoxins such as zearalenone, trichothecenes, fumonisins and Ochratoxin A have also been reported to be removed by LAB (Dalié *et al*., 2010). The mechanism of mycotoxin binding was studied by El-Nezami *et al*. (2000) who explained the importance of cell wall components such as carbohydrates and proteins, or polysaccharide and peptidoglycan for the binding of mutagens to LAB. Hathout *et al*. (2011) evaluated the preventive role of *Lb. casei* and *Lb. reuteri* against AFs-induced oxidative stress in rats (in vivo) and reported that LAB succeeded to induce a significant improvement in all the biochemical parameters of the liver and prevented the harmful effects of AFs. The authors added that the protective role of these LAB strains may be due to their AFs binding activity as well as their antioxidant properties. In agreement, Kodali and Sen (2008) reported that these bacteria synthesize extracellular polysaccharides with significant physiological and therapeutic activities and have a significant antioxidant and free radical scavenging activities.

These approaches together with clear monitoring criteria and good hygiene practice could contribute to better processing management of fermented cereals and ensure that mycotoxin contamination is minimized during production of the improved dairy product.

Conclusion

Principle control measures and conditions have been developed and implemented to ensure food safety and suitability at all stages of the food chain resulting in the good quality of the end product. These form the basis of the hygiene and safety programs in food establishments. HACCP can be applied to several food categories; such as bulk milk, bulk cream and butter production line. Moreover better education of consumers on how to use, transport, and store fresh food products, and also enhancing the use by and sell by dates must be included for food safety.

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