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HAZARD ANALYSIS AND CRITICAL CONTROL POINTS OF MILK AND MILK PRODUCT (YOGHURT) IN A DAIRY FARM IN ZARIA

***Ilozue, C. I., Bello, M and Lawan, M. K**
Department of Veterinary Public Health and Preventive Medicine,
Ahmadu Bello University Zaria, Nigeria
***Corresponding author's e-mail:** chreaz24@yahoo.com *+234 7039075585*

Abstract
Yoghurt is a common milk product consumed in Zaria and its environs. The product can be contaminated with zoonotic pathogens during processing and packaging. This study was conducted in a Dairy Farm in Zaria to analyze the possible points of milk and milk product contamination using the HACCP template. A total of 80 samples were collected of which 30 were swab samples that included 10 samples each, before and after cleaning the udder of the cows and 10 swab samples from the milking bucket. The remaining samples were, 30 from fresh milk, 10 from processing units and 10 from the finished product (yoghurt). The results showed that swab samples before cleaning the udder had a mean total aerobic plate count of 7.1 ± 0.2 Log_{10} CFU/cm^2, while the value after cleaning was 6.9 ± 0.1 Log_{10} CFU/cm^2. The swab samples from the milking bucket had lower contamination with total aerobic count of 6.4 ± 0.1Log_{10} CFU/cm^2. The milk from external sources (Fulani milk) had the highest microbial contamination with total aerobic count of 3.9 ± 0.1 Log_{10} CFU/ml while the pasteurized milk had the lowest microbial contamination, with a total aerobic of 2.2 ± 0.2 Log_{10} CFU/ml. An increased microbial load was observed following analysis of the yoghurt, with total aerobic plate count of 2.7 ± 0.1 Log_{10} CFU/ml. It was concluded that there is need to improve personal and environmental hygienic practices as while as the packaging procedure in the dairy farm.
Keywords: HACCP, Milk, Yoghurt, Aerobic plate counts, CMT

Introduction
Yoghurt is an acidified, coagulated product obtained from milk by fermentation with lactic acid-producing bacteria. It is a milk product obtained by the fermentation of milk by the action of symbiotic cultures of *Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus* and resulting in reduction of pH with coagulation (FAO/WHO, 2002). Fermentation of milk is probably one of the earliest forms of preservation (Scott, 1981). Yoghurt is a very nutritious food and its continued consumption all around the world owes much to the development of healthy food image of people (Early, 1990). It is also common dairy product consumed all over Nigeria. The quality of yoghurt, or any dairy product, can be defined against a wide range of criteria including chemical, physical, microbiological and nutritional characteristics. Dairy products manufacturers aim to ensure that the safety and quality of their products will satisfy the highest expectations of the consumers.

The most important raw material used in yoghurt manufacture is milk. Milk is defined as that fresh, clean and normal secretion from the mammary gland obtained by milking one or more dairy cows that are properly fed and well kept. It is an opaque white liquid produced by the mammary glands of mammals. It is an important source of carbohydrate, protein, vitamin, fat and minerals in human diets (Adesiyun *et al.*, 1990). Milk, in addition to being a nutritious medium, presents a favourable physical environment for the multiplication of microorganisms and being an animal product is subjected to widely differing production, handling and processing methods, results in its contamination by a broad spectrum of microbial types, chemical residues and cellular

material (Gilmour & Rowe, 1990).The successful manufacture of yoghurt is enshrined in two concepts; good manufacturing practice (GMP) and the hazard analysis critical control point (HACCP) system (Tamime & Robinson, 1999). Hazard analysis and critical control points (HACCP) is a management system in which foods and drinks safety is addressed through the analysis and control of biological, chemical, and physical hazards from raw material production, procurement, and handling to processing, manufacturing, distribution and consumption of the finished products (FAO/WHO, 2002). The HACCP system offers a structured approach to the control of hazards in food processing and, properly applied, identifies areas of concern and appropriate control measures before product failure is experienced. It represents a shift from retrospective quality control through end-product testing to a preventive quality assurance approach. End- product testing against microbiological criteria is shifted to the role of verification in a HACCP program (Jervis, 2002).

The **HACCP** comprises seven principles, which are to:

i. Conduct a hazard analysis.
ii. Identify critical control points.
iii. Establish critical limits for each critical control point.
iv. Establish critical control point monitoring requirements.
v. Establish corrective actions.
vi. Establish record keeping procedures.
vii. Establish procedures for ensuring the HACCP system is working as intended.

There are concerns about the sanitary condition under which these dairy products are produced, which is often produced and packaged by individuals and organizations without regards to basic rules of personal and general hygiene. Adesiyun (1984) found that many milk and milk products in Nigeria were highly contaminated with *Staphylococcus aureus* with counts ranging from 6.2 x 10^7 to 1.8 x 10^9 cfu/ml. Organisms such as coliforms and lactose fermenting yeast have also been isolated from some of these dairy products (Frazier and Westhoff, 1991).

Materials and Methods

***Sampling*:** A total of 80 samples were collected. Sampling was carried out for 10 weeks, with the samples collected twice every week. The samples were collected from the production unit where the dairy cows were being milked and also from the processing unit at various stages of processing of the milk into a finished product (yoghurt). The samples collected include;

i. Swab sample from the teats of the udder before cleaning
ii. Swab samples from the teats of the udder after cleaning the teat of the udder,
iii. Swab samples from buckets used in collecting the milk
iv. Milk samples from the dairy institutional farm
v. Milk samples from the milk purchased from Fulani herdsmen
vi. Milk sample from mixture of the farm milk and the purchased milk
vii. Milk samples following pasteurization
viii. Yoghurt sample

Swab samples were collected using sterile swabs and sample bottles each containing 5ml normal saline solution and the milk samples were collected using sterile sample bottles while the milk samples were collected in cleaned sterile corked tubes which well labeled. The samples were appropriately collected and stored in a flask containing dry ice packs before being transported to the laboratory for analysis.

***Laboratory procedure*:** Samples for analysis were homogenized according to International Standards Organization (ISO) technique (ISO, 1980). The swab samples were serially diluted using a 100-fold serial dilution using physiological saline solution to x10^{-6} dilution. 0.1 ml of the swab

sample was added to 9.9 ml of the normal saline. 0.1 ml of the serially diluted sample was then inoculated on to the Nutrient agar and spread using a hockey stick and then incubated at 37^0C temperature for 24 hours. The milk and the yoghurt samples were serially diluted using a 100-fold dilution up to $x10^{-2}$ by adding 0.1 ml of the milk or the yoghurt sample onto a 9.9 ml of physiological saline, and then 0.1 ml of the serially diluted sample was inoculated onto Nutrient agar after which they were incubated at 37^0C for 24 hours.

***California Mastitis Test (CMT)*:** This is a screening test which is often carried out in the field to give indication as to whether the milk is mastitic or not. This test detects the presence of somatic cells in milk. In this, an equal amount of milk and a California Mastitis test reagent (consisting of a detergent, alkyl aryl sulphonate, and a pH indicator, Bromocresol purple) are added to each of the four quarters of the paddle. The paddle is then gently rocked for few minutes to allow proper mixing of the milk and the regent. The mixture is then observed for evidence of colour change, viscosity and gel formation.

Results

The steps involved in the processing of the bulk milk and production of yoghurt with indication of hazard and critical control points in the institutional dairy farm are illustrated in Figure 1. Mean±SD for the total aerobic counts of the milk samples Log $_{10}$ cfu/ml and the swab samples Log_{10} cfu/cm^2 are shown in Table 1. The total aerobic plate count for swab samples ranged from 6.4 ± 0.1 to 7.1 ± 0.2 while the microbial counts obtained from the fresh milk sample before pasteurization and up to the final product ranged from 2.2 ± 0.2 to 3.9 ± 0.1.

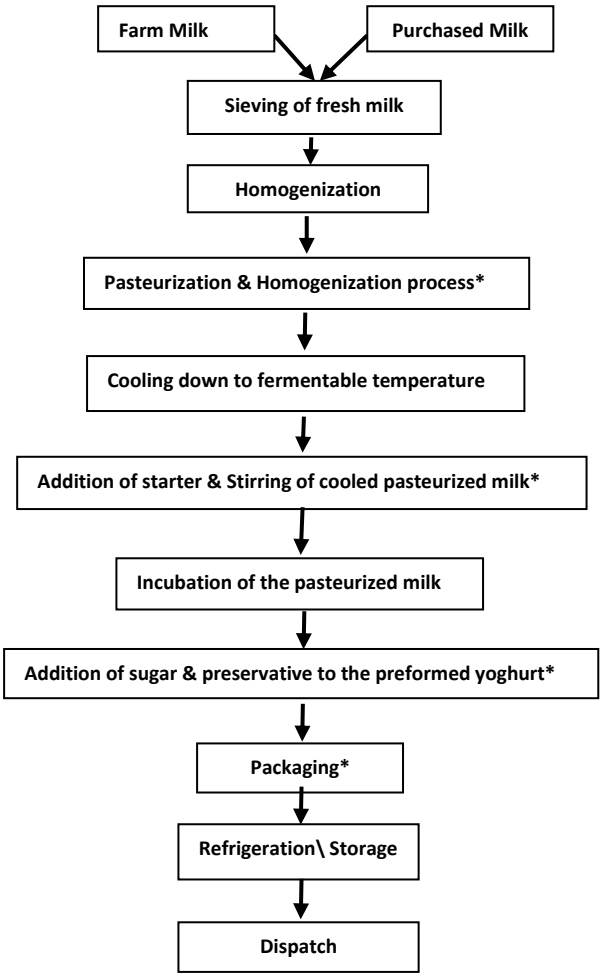

Figure 1: Flow Chart of milk processing and yoghurt production method used in the Institute's Dairy Farm, indicating the hazard and critical control points *** HACCP**

Table 1: Mean ± SD for the total aerobic counts of the milk samples Log $_{10}$ cfu/ml and the swab samples Log_{10} cfu/cm^2

Samples	No. of samples	Total aerobic counts, Log_{10} CFU/ml or CFU/cm^2 (Mean ± SD)
Farm Milk	10	3.4 ± 0.2
purchased Milk	10	3.9 ± 0.1
Fresh Milk Mixture	10	3.7 ± 0.1
Pasteurized Milk	10	2.2 ± 0.2
Yoghurt	10	2.7 ± 0.1
Swab samples before teats cleaning	10	7.1 ± 0.2
Swab samples after teats cleaning	10	6.9 ± 0.1
Swab samples from milking bucket	10	6.4 ± 0.1

The laboratory results for samples collected during the various stages of processing and up to the finished products are summarized in Table 2.

Table 2: Result comparison between samples in relation to the significance of the t - value

Samples	Mean difference	Signif.
Farm Milk and purchased Milk	4766.667	7.72*
Fresh Milk to Pasteurized milk	5077.778	11.44*
Pasteurized Milk to Yoghurt	355.556	9.43*

NB: * indicate that the t – value is highly significant

For California mastitis test (Table 3) the percentage prevalence of mastitis from the purchased milk was as high as 70% while the percentage prevalence of mastitis from the institute dairy farm was 10%.

Table 3: Percentage prevalence on mastitis on the fresh milk samples from different sources using California Mastitis Test

Samples	Mastitic Milk	Non-Mastitic Milk	Total milk	Percentage Prevalence
Farm Milk	1	9	10	10
Purchased Milk	7	3	10	70

Discussion

After microorganism have entered milk, it is difficult to remove them effectively (Frazier and Westhoff, 1991). The data appreciably show the value of conducting hazard analysis critical control point to detect food borne disease hazards and to focus attention on situation where control action is needed, therefore this procedure is necessary in countries that have either rudimentary food borne disease surveillance activities. The higher microbial load of 3.4 ± 0.2 Log_{10} cfu/ml was observed in the milk samples obtained the purchased milk in relation to that obtained from the dairy farm. This could be attributed to gross contamination of the milk during and after milking and a poor storage system. Such microbial contamination of milk is an indication of poor sanitary practices and is identified as a major contribution to health hazard. The reduction in the total aerobic plate count of the milk after pasteurization, 2.2 ± 0.2 Log_{10} cfu/ml is a clear indication about the importance of pasteurization of the milk. This has also been shown to provide good condition for growth of the starter culture. There was an increased microbial count in the finished product 2.7 ± 0.1Log_{10} cfu/ml compared to that observed following pasteurization of the fresh milk and it observed to be higher than the recommended standard of 2.5Log_{10} cfu/ml, fit for human consumption (Adesiyun *et al*., 1990). This could be attributed to the addition of the starter culture and additives to the

processed milk. Some of the additives help prevent the growth of mold in the finished product. A 70% prevalence of mastitis and higher microbial count observed in the purchased milk shows the need to encourage or advise the producer of this fresh milk on the need to maintain good hygienic condition in producing milk from their farms.

Recommendations

i. Encourage and educate local milk producers on the need to maintain good hygienic practice.
ii. Educate workers in yoghurt production on the need to maintain good hygienic practice during production.
iii. Established dairy farms and yoghurt producers should set up a HACCP system to production of yoghurt safe for human consumption.
iv. Further studies to isolate pathogenic organisms and also antibiotic sensitivity test on the isolates
v. further studies on heavy metals identification in the dairy product

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