Improvement Of The Hygienic Quality Of Farmhouse Meat Pies Produced In Burkina Faso

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ABSTRACT

The objective of the present study was to improve the hygienic quality of farmhouse meat pies produced in Burkina Faso. This study revealed that only 6.25 % of the employees have knowledge as regards hygiene and the enumeration of the aerobic flora total, of *Staphylococcus*, sulfite-reducing anaerobic bacteria, total coliforms and of the fecal coliforms using standards microbiology methods, not compliance with the rules of hygiene shows because only the search for *Salmonella* gives satisfactory results. The number of micro-organisms increases from the workshop instead of sale (shop). What as well reveals not respect of the cold-chain on the level of the workshop as to the shop (+5° C). The difference is significant for *Staphylococcus*, sulfite-reducing anaerobic bacteria, total coliforms and the fecal coliforms (P<0.05) and not significant for the total aerobic flora (P > 0.05) between workshop and shop. These results show an evolution of the number of germs in meat pies between the workshop and the shop and consequently a contamination of the finished product and not the respect of the cold-chain. This study makes it possible to improve hygienic quality of meat pies by application of the preventive measures to the dangers determined thanks to the use of the HACCP decision tree.

Key words: Improvement, hygienic quality, farmhouse meat pies, microorganisms

Introduction

The quality assurance is currently a fundamental concern for the food industry. Quality is characterized by the standards, the labels, the names. It is obtained by the application of well defined and controlled procedures. It is controlled by systems of checking, standardized techniques of analysis. Hygiene is necessary in food industry. It makes it possible to obtain healthy and valid food. It increases the duration of storage and takes part in the genesis of quality and ensures the confidence of the consumer in the mark. A fault or a manufacturing defect involves a heavy loss [15]. Food elaborated with satisfactory hygienic standards is one of the essential conditions for promoting and preserving health [22]. Nowadays the meat industry represents one of the principal sectors of food industry. Indeed, the meat and its products occupy a place of choice in our food as well for nutritional reasons as for sociocultural reasons [9]. In fact, the flesh of the mammals contains on average 18 % of proteins, 75.5 % of water, a low or zero rate of carbohydrates and a fat content fluctuating rate [4]. In Burkina Faso the farmhouse meat pies production became more and more important; many small enterprise are involved in it production. It became indispensable to have an regard in the quality of the production process and the ends products. In general HACCP is considered as indispensable prerequisite system should a food producer wish his products to enter or recognize by international market [5,20,1,35]. Since pathogens incidence are still increasing in food, developments of food process control giving best hygienic products to all consumer become urgent task for all food industries business promoters or governments [36]. The present study aimed to improve the hygienic quality of the farmhouse meat pies produced in Burkina Faso with using HACCP system, microbiology analysis and hygiene practice appreciation.

Materials And Methods

1. Follow-up of the technology of farmhouse meat pies:

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To follow up the technology of meat pies, was done by observation of all the process steps from the raw material to the end products (farmhouse pies).

2. Evaluation of Good Hygiene Practices by producers:

To evaluate knowledge of Good Hygiene Practices of the employees working in the workshop, we drew up some cards of investigation which was subjected to the entire staff. Then, we watched discretely the actions during the production, the environment in which the raw material was transformed and the cleanliness of the material used during the transformation.

3. Critical control point (CCP) determination and hazards analysis

The HACCP system offers an approach to the control of hazards in all food processing, food technology and properly applied, identifies areas of concern and appropriate control for improving foods quality. The HACCP decision tree illustrated in the figure 1 was used to determine the critical control points (CCP) on the level of the technological diagram of farmhouse meat pies. A critical control point (CCP) is a point, step, or procedure in a food manufacturing process at which control can be applied and, as a result, a food safety hazard can be prevented, eliminated, or reduced to an acceptable level.

**Microbial analysis:**

4.1. Sampling and dilution:

Sixty (60) samples of meat pies were analyzed including thirty (30) taken at the workshop and thirty (30) at the shop. Thirty (30) samples of meat pies from the workshop and thirty (30) samples of meat pies from the shop were made.

Ten (10) g of each sample were suspended in 90 ml of 0.85 % (w/v) sterile diluent and thoroughly homogenized using a lab-blender stomacher for 4 min. Serial 10-fold dilutions were done by transferring 1 mL to sterile diluent.

4.2. Enumeration of total aerobic microorganisms:

0.1 ml of appropriate dilutions was transferred separately to plates of surface-dried Violet Red Bile Agar with Lactose (VRBL) (Fluka Biochemika 70189). After incubation at 30°C (total coliforms) or at 44°C (fecal coliforms) for 24h under aerobic conditions, the number of colony forming units per gram (cfu/g) of food was calculated.

4.4. Enumeration of Staphylococcus:

0.1 ml of appropriate dilutions was transferred separately to plates of surface-dried Chapman’s medium. After incubation at 37°C for 24h under aerobic conditions, the number of colony forming units per gram (cfu/g) of food was calculated.

4.5. Enumeration of the sulphite reducing anaerobic bacteria:

0.1 ml of appropriate dilutions was transferred separately to plates of surface-dried Chapman’s medium. After incubation at 37°C for 24h under aerobic conditions, the number of colony forming units per gram (cfu/g) of food was calculated.

4.6. Enumeration of Salmonella:

The enumeration of Salmonella was done according to the method described by IS: 5887, 1999 (IS: 5887, 1999).

**Analysis of data:**

The 3-class plan system developed by the International Commission for Microbiological Specifications for Foods were used to interpret the results [17]. In order to compare the values obtained at workshop to those of the shop, microbial counts were converted to log10 CFU/g. Statistical analysis was performed by means of SPSS 17.0 software. The data were treated with the Excel software in order to determine the means, the standard deviations and the least significant difference between values [30] and t-student test, and variance analysis (significance at P<0.05) were applied on microbial counts.

**Results And Discussion**

1. Farmhouse meat pies:

The steps of the production of farmhouse meat pies are shown in Figure 2

2. Evaluation of knowledge of Good Hygiene Practices:

The results of the investigations and the reports made with the workshop show that the majority of the employees do not have Good Hygiene Practices.
Approximately 6.25% of the employees state to have received a formation on Good Hygiene Practices. For some, Good Hygiene Practices only consist in washing the hands with the soap after having been with the toilet. That was not respected during the survey.

An annual medical visit is made for all the employees but in the event of infectious disease like the cold and cough those are not exempted to work and do not carry either of bucco-nasal mask. In the event of accidental wound, there is no adequate material for the bandage. All this constitutes a significant source of contamination during various handling. With regard to vestimentary hygiene, enough of means were leveled this because all the employees carry, aprons, caps covering their head partially even if often the state of property of these behaviors remains to be wished. They also carry safety shoes.

3. Analysis of the hazards (CCP):

The application of the HACCP decision tree (Figure 1) during the process of meat pies allowed us to list the critical control points (CCP) presented in table 1. In this table 1 here are two kinds of hazards: the biological and the chemical. Chemical hazards determinate were less serious than the biological ones. The biological hazards determinated were due to a defect of heat treatment or a contamination of the product in the workshop and in the shop. Preventive measures were suggested in order to avoid these hazards. Generally small food companies have often difficulties [23,31,34,2] to enter or in addressing national and international legislation on food safety and Quality (lack of technical trained personnel, human resource constraints, lack of expertise and/or technical support, economical constraints).

![HACCP decision tree](image)

**Fig. 1: HACCP decision tree**

**Table 1:** The critical points obtained by the HACCP diagram on farmhouse meat pies

<table>
<thead>
<tr>
<th>CRITICAL POINTS</th>
<th>POTENTIAL hazards</th>
<th>SEVERITY</th>
<th>PREVENTIVES MEASURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAW MATERIALS</td>
<td>CHEMICAL</td>
<td>Risk of allergic reactions</td>
<td>VERY low</td>
</tr>
<tr>
<td>COOKING OF THE PASTES in THE FURNACE</td>
<td>Resistance of certain bacteria to heat; Risk of microbial proliferation; Risk of contamination by the probe.</td>
<td></td>
<td>Strict respect of the scales of cooking; Checking and respect of the temperatures at the end of the cooking; Cleaning and disinfection of the probe before/after each use.</td>
</tr>
<tr>
<td>COOLING OF THE PASTES IN COLD ROOM</td>
<td>Recontamination of pies in the polluted air of the cold room; cross contamination with the fresh products</td>
<td>HIGH</td>
<td>Cleaning and weekly disinfection of the cold room; Physical separation of the products of different nature regularly Checking of the temperature in the cold room; checking of the temperature at the end of the cooling</td>
</tr>
</tbody>
</table>
Microbial analysis:

The results of the microbial analysis of farmhouse meat pie concerning the total aerobic bacteria (TAB), the *Staphylococcus* (STAPH), the sulphite reducing anaerobic bacteria, the total coliforms (TC) and the fecal coliforms (FC) are presented in table 2. The contamination of the products was observed at the workshop as well as at the shop. This is an indication of recontamination due to food handling [18,21]. Phillips [25] found that meat offers a rich nutrient media for microbial growth [25].

The total aerobic bacteria (TAB) ranged between $1.9 \times 10^4$ and $2.3 \times 10^6$ cfu/g at the workshop and between $2.0 \times 10^4$ and $9.3 \times 10^6$ cfu/g at the shop (table 2).

![Table 2: Microbial analysis of meat pie](image)

The highest average was noted in batch 5. Batch 5 of farmhouse meat pies taken at the workshop is consequently regarded as acceptable. The farmhouse meat pies from batch 5 at workshop were satisfactory.

At the shop, batches 3, 4 and 6 showed satisfactory values according to the standard. Batches 1 and 5 with intermediate average values were considered acceptable. Only batch 2 presenting a very high average value was considered unsatisfactory. Ho [16] found values of total aerobic bacteria varying from $10^4$ to $3 \times 10^5$ cfu/g that were lower than the values in the obtained in study. [8] reported $3 \times 10^5$ and $5 \times 10^5$ cfu/g of total aerobic bacteria in fresh meat. Total aerobic bacteria counts are a measure of hygiene rather than specific pathogen detection [11].

*Staphylococcus* counts in farmhouse meat pies ranged from $1.1 \times 10^7$ to $1.5 \times 10^6$ cfu/g at the workshop and from $3.7 \times 10^5$ to $5.4 \times 10^6$ cfu/g at the shop. All the batches of farmhouse meat pies contained in high number *Staphylococcus* germs exceeding the tolerance limits and all batches are considered unsatisfactory.

Ho [16] who found values ranging from...
The batches of farmhouse meat pies at the workshop as well as at the shop contained a high number of sulphite reducing anaerobic bacteria exceeding the acceptable limits. The average values varied from 8.3x10² to 3.5x10³ cfu/g at the workshop and from 1.1x10¹ to 1.7x10⁶ cfu/g at the shop. All the batches of pies were found unsatisfactory for the sulphite reducing anaerobic bacteria. These results indicate an insufficiency of the heat treatment of meat pies because the sulphite reducing anaerobic bacteria are known to be thermoresistant through spores production.

The enumeration of total Coliforms in farmhouse meat pies at the workshop showed average values varying between 1.1 x 10⁰ to 2.5x10⁶ cfu/g (table 2). Results of batches 3 and 6 were considered to be satisfactory by having respectively values of 2.3x10³ and 1.1x10⁵ cfu/g compared to the standard relating to total Coliforms. Results of Batches 1 and 4 were acceptable whereas batches 2 and 5 were unsatisfactory. Concerning meat pies at the shop, the results of total Coliforms showed values exceeding the acceptable limits of the established standards. All the batches at the shop were considered to be unsatisfactory for total coliforms. The total coliforms because of their sensitivity to heat, their presence in cooked food indicate a contamination after heat treatment [6]. Ho [16] found values varying from 10 to 40 cfu/g.

The enumeration of fecal Coliforms in all the batches of meat pies meat pies indicated values exceeding the acceptable limits. These values varied from 2.6x10² to 3.4x10⁵ cfu/g and from 3.6x10⁷ to 3.1x10⁶ cfu/g respectively at the workshop and at the shop. All the batches of meat pies at the workshop and at the shop were unsatisfactory quality as regard to the fecal coliforms. They are indicators useful of hygiene and contamination post process of the products having undergone a treatment for heat. But the high rate of fecal Coliforms observed in meat pies indicates an insufficient heat treatment. The presence of high number of the fecal coliforms in meat pies is an indicator of fecal contamination.

Coliforms after processing and Staphylococcus in processed food are indirect indicators of pathogens [11].

Salmonella was not observed in our samples of farmhouse meat pies. The absence of Salmonella in our samples of farmhouse meat pies at the workshop and at the shop is a satisfactory result because Salmonella are pathogenic and responsible for numerous food poisoning [28]. The microbial contaminants can come from many sources. In fact, bacteria are introduced into the chain of farmhouse meats process by the animals themselves which convey them in their gut and on their skin [27,12], these elements constitute the principal sources of contamination of the carcasses at the time of demolition [13,7]. The contaminated raw materials, the equipment not perfectly cleaned and of the employees not respecting strictly hygiene instructions can constitute potential sources of contamination. Accidents related to the process can be also the cause of proliferations of pathogenic micro-organisms [33]. In the last case, the micro-organisms can come from the raw meat or can be introduced into the process by not respecting the rules of hygiene.

The storage temperatures varied between 8.10° C and 13.5° C at the workshop and between 8.02° C and 10.42° C at the shop. These values respect the criteria of cold-chain system. Each cooled product must be maintained at a suitable temperature. For instance, a maximum temperature for the meats and poultries was 4° C [26]. On the hygienic level, the growth of the microorganisms will be all the more limited that cooling will be early and fast [14]. The maintenance of the cold-chain system is an effective means to prevent the growth of microorganisms in food products [24].

Figure 2 (a, b, c, d, e) shows the evolution of microorganisms in farmhouse meat pie from the workshop to the shop. The number of germs at shop is higher than those at the workshop. Statistical analysis of log cfu showed a significant difference (P<0.05) for Staphylococcus, sulphite reducing anaerobic bacteria, total coliforms and fecal coliforms but no significant difference was observed as regards to total aerobic bacteria (P>0.05).

The result shows not only an initial contamination but more especially a multiplication of the germs during the storage of the finished products could be explain by a bad handling of food by employees not respecting the requirements of hygiene or bad conditions of storage involving the fast multiplication of these germs. At temperatures higher than +5° C, Enterobacteriaceae can develop in a prevalent way. Enterobacteriaceae count is a measure of hygiene rather than specific pathogen detection [11].
Fig. 2: Meat pies process and Critical control point determination

b) *Staphylococcus*

![Diagram of meat pies process and Critical control point determination]

![Graph of log CFU vs samples for total aerobic bacteria]

![Graph of log CFU vs samples for *Staphylococcus*]

The analysis of these results shows a contamination during the production and the marketing. However we note an increase of germs at the shop. That could be explained not only by a problem of conservation before marketing but a contamination of the raw meat which did not undergo a sufficient heat treatment. Between the setting on sale of the products and their purchase by a consumer, the bacterial load can increase depending on the packaging and the temperature. Consequently, the correct implementation of the techniques of packaging associated with the strict respect of the cold-chain system are extremely important for the microbiological quality of the products on the place of sale. Similar results were reported by Clarence et al. [8] who found an increase of the number of micro-organisms (aerobic bacteria, Staphylococcus, Escherichia coli) in meat pies.
during storage time. The presence of these organisms in ready to eat food (meat pie) depicts a deplorable state of poor hygienic and sanitary practices employed during the processing and the packaging of these food products. However, even with rigorous conditions of storage, beyond a certain time, the number of micro-organisms will reach an unacceptable level. The medical respect is the only solution to maintain the quality of the product. Food poisoning/illnesses are entirely preventable by practicing good sanitation and food handling techniques [3]. According to Doyle and Evans [10], food borne diseases are diseases resulting from ingestion of bacteria and toxins produced by microorganisms in food.

Conclusion:

The reinforcement of food safety is an increasingly keen demand of the consumers. The prepared meat products are products increasingly coveted by the consumers hence the need to ensure quality products for them. The follow-up of the manufacturing processes of farmouse pie, the evaluation of knowledge as regards hygiene and the microbiological analyses of pie helped establish a technological diagram of manufacture of pie and to evaluate the microbial flora of this pie. At the end of our study, we noted that the majority of the pie samples contain high number of germs exceeding the acceptable limits. The results obtained are unsatisfactory especially concerning knowledge about hygiene and the microbiological results. Hence there is ignorance, therefore a bad application of the hygiene rules to the chain of production, during the storage and marketing of farmhouse meat pie. The high rate of germs in pie at the workshop informs us about an insufficiency of the heat treatment, a non-application of cooking scales and a poor storage of the product after cooking. The strict application of the preventive measures would improve the hygienic quality of meat pies at the workshop and the shop.

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