

The Quality of Jordanian Sausage Products Stored at 4°C

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Abstract: The microbial and chemical profiles of ten types of Jordanian sausage products were monitored on the production day and after 60 days of storage at 4°C. Samples were collected on days 0 and day 60 and tests of pH value, moisture content, bacterial counts and physical appearance were conducted. The findings designated slight statistically significant changes in samples' quality during the storage time. Thus, storing sausage at 4°C is satisfactory to preserve its quality. The hygienic quality of the raw materials is the main factor affecting the final value of the product. All the products in the study fit the Jordanian standards of specification.

Key words: Sausage, quality, microbial analysis, chemical analysis, 4°C, meat preservation

INTRODUCTION

Sausage is a very popular tasty food overall the world. Essien (2003) defined it as a comminuted processed meat product made from red meat, poultry or a combination of these with water, binders and seasoning. It is usually stuffed into a casing and may be cured, smoked or cooked. The issue of the storage temperature is vital because quality is probably the most important dimension that consumers care about. Contamination could happen during production, processing or distribution. From the manufacturer to the consumer, the sausage product must have sufficient shelf life. Safe sausage products can be obtained through the use of high quality raw materials, sufficient processing methods and maximum procedures of hygienic requirements. FAO (1985) reported three basic requirements in order to get a hygienically satisfactory sausage product:

- Conditions of sausage production must be such that should toxigenic organisms be present in or gain access to the product prior to during or after processing, no bacterial toxins are formed
- The final sausage product should not contain microorganisms likely to be pathogenic to man

- The total bacterial count of the sausage product should be reasonably low so that no decomposition or development of undesirable flavor occurs during the period of processing, distribution or storage

Special problems may arise if the sausages are to be held in particularly warm and humid conditions promoting bacterial growth.

Researchers found that microbial spoilage of sausages is affected by processing temperature, available water and its activity in meat, oxygen, pH-value and the salt and nitrite contents (Boyle, 1994; Quasem *et al.*, 2009; Sureshkumar *et al.*, 2006). Recently, Kamenik *et al.* (2012) investigated the influence of different storage temperatures (5 and 15°C) on the quality of vacuum-packed dry fermented sausage. Their tests included physical, chemical, sensory and microbiological analyses. They showed no differences in sensory properties or basic physical/chemical and microbiological parameters in the products after storage under the two different temperature conditions for 120 days.

Research is limited on processed meat products in Jordan. Indeed, there are no studies carried on the storage stability of Jordanian sausage products to the best of researchers' knowledge. Thus, shelf-life studies can

provide important information to ensure that the consumer will get high quality product for a significant period of time after production.

MATERIALS AND METHODS

Researchers investigated the quality of ten types of sausage products stored at 4°C. Specifically, sausage samples were collected on the day of production when they were fresh and 60 days thereafter. The samples were stored at 4°C during the 60 days period. Both microbial and chemical analyses were conducted. The chemical analysis included testing the pH and moisture values. The microbial analysis included estimating the total bacterial count of coliform, staphylococci and yeast and molds. Triplicate was executed for each test whether it was a chemical or microbial. Tests are explained in details as follows:

Chemical analysis

pH measurement: Potentiometric measurements of pH were made using a pin electrode of a pH meter (Radiometer Copenhagen pH M82, Cecchinato, Italy) which was inserted directly into the sample. Three independent measurements were made on each sample.

Moisture: Each sample was ground using mortar and the atmospheric oven method was used to determine the moisture content of the sausages. Moisture contents were determined in triplicate using the AOAC (1995) methods.

Microbial analysis: The determination procedures of Lin and Huang (2003) were followed to detect microbial counts. Serial dilutions from sausage samples were prepared in sterile 1% (w/v) peptone water. Ground sausage samples (25 g) were emulsified in 225 mL of mL sterilized 0.1% peptone solution and homogenized using an Ultra-Turrax mechanical blender (19,000 rpm for 45 sec). Serial dilutions were prepared in sterile 1% (w/v) peptone water, plated on selective agar and incubated at

the appropriate temperatures. The total bacterial counts were enumerated on (NA) Nutrient Agar (Difco); plates were incubated for 48 h at 32°C. For counting the total coliform bacteria, the VRBA (Violet Red Bile Agar) medium (Difco) was used as recommended by the APHA (1960); plates were incubated at 37°C for 48 h. Manitol Salt Agar (MSA) medium (Biolife) was used to enumerate the total staphylococci; plates were incubated at 37°C for 48 h. Potato dextrose agar was used for detecting yeast and molds as described by Difco Laboratories (1984); the plates were incubated for 7 days at 25°C.

Statistical analysis: The data obtained were analyzed for statistical significance using the Least Significant Difference (LSD) estimated via SAS Software. LSD is used to compare means of different treatments that have an equal number of replications (SAS, 2000).

RESULTS AND DISCUSSION

Many shelf stable meat products can be stored indefinitely without the risk of microbial spoilage as long as the original package is not opened. The quality of the product, however may change over time. Since, food is dynamic, reactions among food molecules are continually occurring. This can lead to changes in the texture, color, flavor and aroma of the product over time. For this reason, many companies may indicate a use by date on the product label so consumers receive optimum product quality. Shelf stable meat products offer consumers convenient and good tasting products that do not need refrigeration (Boyle, 1994).

Table 1 shows the results of microbial and chemical analysis of sausage samples at the day of production. The pH values of different types of sausages ranged from 6-6.37 depending on the glycolytic potential at the time of slaughter. The normal variation of pH is 5.4-6. The pH is an important determinant of microbial growth and the sausage samples which have a pH value close to the

Table 1: Microbial and chemical analysis results at the day of production

Sausage types	Total bacterial count	Total coliform	Total staphylococci	Mold and yeast	pH	Moisture (%)
Mortadella plan	3.3×10 ^{2a}	<30 ^a	5.0×10 ^a	1.7×10 ^{2d}	6.33 ^d	65.51 ^c
Mortadella with olive	2.1×10 ^{2a}	<30 ^a	7.3×10 ^a	6.0×10 ^a	6.37 ^e	63.26 ^b
Mortadella with pepper	1.2×10 ³	<30 ^a	6.0×10 ^a	1.1×10 ^{2b}	6.30 ^e	64.92 ^b
Mortadella with pistachio	3.0×10 ^{2a}	5.0×10 ^a	7.3×10 ^a	7.0×10 ^a	6.37 ^e	63.43 ^b
Silsisio	3.0×10 ^{2a}	7.0×10 ^a	9.0×10 ^b	5.7×10 ^a	6.30 ^e	66.95 ^c
Frankfurter	7.6×10 ^{2c}	1.6×10 ^{2c}	1.7×10 ^{2c}	4.7×10 ^{2b}	6.37 ^e	64.28 ^b
Smoked salami	2.7×10 ^{3b}	7.0×10 ^a	1.3×10 ^{2b}	9.0×10 ^b	6.00 ^a	59.53 ^a
Roast turkey with vegetables (block)	4.0×10 ^{3b}	9.0×10 ^b	1.0×10 ^{2b}	2.0×10 ^{2b}	6.20 ^b	59.50 ^a
Smoked roast turkey product	1.7×10 ^{4d}	1.5×10 ^{2c}	1.5×10 ^{2c}	1.5×10 ^{2c}	6.20 ^b	59.52 ^a
Roast beef	1.9×10 ^{4a}	2.3×10 ^{2d}	2.0×10 ^{2c}	1.3×10 ^{2c}	6.00 ^a	59.50 ^a
Jordanian standards of specification					>6.50	<70 more

^{a-e}Means with no common letters within column differ significantly; Values are average of three replicates

Table 2: Microbial and chemical analysis results after 60 days of storage

Sausage types	Total bacterial count	Total coliform	Total staphylococci	Mold and yeast	pH	Moisture (%)
Mortadella plan	3.5×10 ^{2a}	3.5×10 ^a	4.5×10 ^a	2.0×10 ^{2b}	6.30 ^c	65.49 ^c
Mortadella with olive	2.5×10 ^{2a}	<30 ^a	8.5×10 ^b	6.5×10 ^a	6.40 ^c	63.23 ^b
Mortadella with pepper	1.2×10 ^{3b}	<30 ^a	6.0×10 ^a	1.5×10 ^{2d}	6.30 ^c	64.89 ^b
Mortadella with pistachio	3.5×10 ^{2a}	5.0×10 ^b	8.0×10 ^b	7.0×10 ^a	6.35 ^d	63.43 ^b
Silsisio	3.0×10 ^{2a}	7.0×10 ^b	9.0×10 ^b	6.0×10 ^a	6.30 ^c	66.93 ^c
Frankfurter	7.0×10 ^{3d}	2.0×10 ^{2d}	1.6×10 ^{2d}	3.5×10 ²	6.35 ^d	64.28 ^b
Smoked salami	2.5×10 ^{3b}	7.0×10 ^b	1.2×10 ^{3c}	8.5×10 ^b	6.00 ^a	59.49 ^a
Roast turkey with vegetables (Block)	4.0×10 ^{3c}	9.0×10 ^b	1.0×10 ^{3c}	2.0×10 ^{2b}	6.20 ^b	59.51 ^a
Smoked roast turkey product	4.0×10 ^{3c}	2.0×10 ^{2d}	1.0×10 ^{3c}	1.0×10 ^{3c}	6.20 ^b	59.50 ^a
Roast beef	1.9×10 ^{4e}	2.5×10 ^{2e}	2.5×10 ^{2e}	1.0×10 ^{2c}	6.00 ^a	59.50 ^a

^{a-e}Means with no common letters within column differ significantly; Values are average of three replicates

equilibrium has a high spoilage potential and a short shelf life (Newton and Gell, 1981). Walker and Betts (2000) reported that the ultimate pH value of meat was significant for its resistance to spoilage because most bacteria grow optimally at about pH 7 and not well below pH 4 or above pH 9 (Jamilah *et al.*, 2008). Dharmaveer *et al.* (2007) reported (6.44) initial PH of fresh sausage in their study. Deva and Narayan (1988) and Dharmaveer *et al.* (2007) reported that microbial load increased with the increase in final pH of the meat product.

Moisture content of sausage products at the day of production ranged from 59.5-66.9%. The amounts of water contained in these different products were regulated by the Jordanian Standards of Specification (JSS). Thus, according to these standards, the moisture content should be <70%. Consistently, Agnihotri and Pal (2000) mentioned that the moisture content of sausage is 66.7%. Water is added to many products for several reasons. Some products would be dry and unpalatable without adding water. Using water improves tenderness and juiciness and it serves as a processing aid when the product is made.

The total bacterial count ranged from 2.1×10² CFU g⁻¹ in Mortadella with olive to 1.9×10⁴ CFU g⁻¹ in roast beef at the day of production. The maximum count of total coliform was 2.3×10² CFU g⁻¹ in roast beef while the maximum count of total staphylococci was 2.0×10² CFU g⁻¹ in the same sausage sample. Mold and yeast count ranged from 5.7×10 CFU g⁻¹ in silsisio to 4.7×10² CFU g⁻¹ in frankfurter. Overall, these counts of bacteria and yeast and molds are not considered as a serious contamination risk that may cause microbial spoilage.

Table 2 shows the results of microbial and chemical analysis of sausage samples after 60 days of storage. The pH values were nearly the same. Thus, there were no clear changes in these values. They still fit the Jordanian standards of specification. Generally speaking, total bacterial counts of sausages stored under refrigeration for all treatments increased slightly with increasing storage time. The total bacterial count in Table 2 ranged from

2.5×10² CFU g⁻¹ in mortadella with olive to 1.9×10⁴ CFU g⁻¹ in roast beef. The maximum counts of total coliform, total staphylococci, mold and yeast were 2.5×10² CFU g⁻¹ in roast beef, 2.5×10² CFU g⁻¹ in roast beef and 3.5×10² CFU g⁻¹ in frankfurter, respectively. Once again, these counts did not result in microbial spoilage. Moreover, a physical appearance test showed normal color, flavor and texture after 60 day of storage of all sausage samples. The results indicated no fermentation process was taking place during the storage at 4°C. Accordingly, storing sausage at 4°C was adequate to preserve the quality of the stored sausages. The hygienic quality of the raw materials was the main factor affecting the final value of the product.

The results are consistent with Cocolin *et al.* (2004) who found that refrigeration at 4°C preserve sausage products. Furthermore, Jamilah *et al.* (2008) found that other way to extend the shelf life of fresh beef is by the use of organic acids such as citric acid, acetic, lactic and tartaric acids in individually or in combination. Dharmaveer *et al.* (2007) found that vacuum packaging of smoked chevon sausages had no definite advantage in preserving quality and sensory attributes. Product can be stored under refrigeration up to seven days irrespective of packaging condition.

CONCLUSION

Sausages are products that fit the Jordanian standard specifications with a pH value of <6.5 and moisture content that is <70 more. Chemical and microbial analyses of samples of ten different types of sausage at the day of production and after 60 days of storage at 4°C showed the following results: No fermentation process occurred during the storage time, thus the hygienic quality of the raw materials is the main factor affecting the final value of the product. This study allowed us to obtain a complete picture of the quality of the Jordanian sausage products stored at 4°C.

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