



Evaluation of Smoked Meat Mortadella Products in Khartoum Markets

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Abstract

This study was designed to evaluate physio-chemical characteristics, sensory attributes and microbiological quality of the smoked meat products (Mortadella) in Sudanese local markets. The samples were collected randomly which were processed by different four meat industries in Sudan. The data were subjected to analysis of variance using the general linear model procedure. The results clear that the smoked meat products (Mortadella) in Sudanese local markets from four different meat industries were statically the same in contents moisture%, protein%, storage loss, peroxide and acid value, sodium chloride and total viable bacteria count. The pH value, water holding capacity, fat, and ash content%, beside total energy content of the products had significantly differences ($P < 0.05$) among different samples. The results shows Sensory attributes of Mortadella products were assessed by panelist were statistically the same except in tenderness, juiciness which were significantly different ($P < 0.05$). It could be concluded that the Mortadella products from the different four industries have the same physio-chemical, sensory attributes and microbiological quality except fat and Ash% beside yellowness and lightness.

Keywords: *mortadella, products, physo-chemical, quality, sensory, storage.*

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Introduction

In the meat industry, a major goal is to obtain the highest yield and commercial utilization of slaughter by-products in order to reduce environmental impact and improve economic performance, or at least, reduce the cost of managing these wastes (Brasil, *et al.*, 2014). Meat products are widely consumed

foodstuffs. In addition to appreciable sensory aspects, meat products have a relatively low price when compared to traditional in natural meat cuts. Mortadella is a cured, emulsified and stuffed meat product that provides lower social classes access to animal proteins, making the minimal recommended protein intake possible (Feiner, 2006). Mortadella is an increasingly popular meat production in

Sudan and neighboring countries because of its pleasant taste and texture, high nutritional value and ease of incorporation into sandwiches. In Sudan, mortadella is sold as cylindrical rolls incasing or sliced and vacuum packed (Al-Shuibi,1999). Originally, mortadella was a traditional cured, cooked Italian sausage, but the version made in Sudan and neighboring countries is an emulsion type sausage. The mortadellas are among the meat products the most commonly consumed in Brazil and according to the latest survey data from the IBGE (2010) the consumption reached 0.827 kg/per capita/year, whereas the South Region showed higher domestic consumption (1.599 kg/capita/year). In Arabic and Islamic countries, pork meat and its products are not consumed for religious reasons and mortadella is produced from beef or poultry meat. To date, however, there have been no investigations of the suitability of beef and sheep meat for the production of mortadella, the processing technology required, microbiological and chemical properties or changes in quality of the mortadella during storage or translation. This research discusses the technological conditions that are necessary for manufacturing the product in a way which ensures consistency of mortadella properties. As specific Sudanese standards are mandatory, care was taken to ensure that the manufactured mortadella was reproducible and met legal requirements. The raw meat, dough mix and the finished product were analyzed chemically and microbiologically, as these aspects are associated with product quality and stability (Allaet *al.*, 2015).The mortadella is a meat product present in a great proportion products of the human diet. The Flavour, colour and taste play a decisive role in consumer acceptance. Changes in the sensory attributes of mortadella could be due to the rancidity. Lipid oxidation is a chemical phenomenon that cannot be avoided during

the storage of meat products, but it can be diminished by adding antioxidant substances that provide more stability and avoid the rancidity of the fat (Brasil, 2000; 2011; Doménech-Asensi *et al.*, 2013). This study was aimed to evaluated physio-chemical, sensory attributes and microbiological quality of mortadella products processed by four different industries in Khartoum local markets, and determines the quality attributes of mortadella products with recipes the standards set by the Sudanese standards and metrology organization (SSMO. 2008).

Materials and Methods

Samples collection

Samples of smoked meat products (Mortadella) were purchased from local markets in Khartoum state, processed by different four meat industries company A, B, C, and D. The products were evaluated using five replicates among five month.

Chemical composition:

The Chemical compositions of samples were measured according to standard methods of AOAC (1980). Crude protein was determined using a foss tecator Kjeltac 2300 Nitrogen/Protein Analyzer. Fat was determined by soxhlet extraction of the dry sample, using petroleum ether. Ash content was determined by ashing samples in a muffle furnace at 500C for 24h. The ultimate pH of mortadella products samples determined by using pH meter. The pH meter was calibrated with buffers 4 and 7.

Meat quality attributes:

mortadella products were prepared for colour sensing and covered by polythene sheets. The colour was determined using a Hunter-Lab Tristimulus colorimeter (Model D22 M.Z, Hunter Associated Lab. Inc., Virginia, USA). Hunter (L) lightness,

(a) redness and (b) yellowness were recorded before and after storage. Duplicate samples, each of approximately 0.5 gm of two products, were placed on a humidified filter paper (Whatman No. 4 in adessiccator over saturated KCl solution) and pressed between two plexiglass for 1 min at 25 Kg/cm². Meat and moisture areas were measured using a compensating planometer. The result was expressed as ratio (Grau and Hamm, 1953). Water Holding Capacity (WHC) = [Loose water area-meat film area] ÷ meat film area. The storage loss % was determined by taking the initial weight of the mortadella products after processing immediately and then after the storage period (five weeks). The frozen samples were left overnight in a refrigerator at 4oC for thawing and then weighed.

Peroxide value

Peroxide value was analyzed using AOAS Official Methods (1998).

Acid Value

This was estimated by the way of (ISO 1983).

Storage Loss (%)

The storage loss % was determined by taking the initial weight of the products (Mortadella) after purchased and then after the storage period (one month).The frozen samples were left over night in refrigerator at 4c for thawing and then weighted.

Microbiological Analysis

Ten grams of each sample were weighed aseptically and homogenized in 90 ml of sterile diluent (0.1% peptone water to give 10 dilution). Aseptically 1ml from the dilution 10⁻¹ was transferred to a tube contacting 9 ml sterile diluent. This made dilution to10⁻². In the same way preparation of serial dilutions was continued up to dilution of 10-6. Serial dilutions were sterilized by autoclaving at 121°C for 15 minutes under pressure 151b/in². Total bacterial viable count (TBC)

and total coliforms were carried out as described by Harrigan (1998).

2.1.5 Determination of Sodium chloride

Mineral of samples were extracted according to Person (1981).

Sensory attributes

The sensory evaluation was conducted in the sensory evaluation facilities of the Meat laboratory, Samples were separately 11 semi-trained panelists were used to evaluate the mortadella products samples. The evaluation included, colour, tenderness, flavour and juiciness using an 8-point scale score (hedonic scale) card as described by Cross and Overby (1988).

Statistical analysis

Data were subjected to analysis of variance using the general linear model procedure (SAS 2001). Means with a difference of (P < 0.05) were considered to be significantly different.

Results and Discussion

chemical composition

Chemical analysis of the different Mortadella samples processed by four different companies (table 1) were statically the same (p<0.05) in moisture% and protein%, the moisture % of this results is in agreement with that of Mariusz ., *et al* (2011), which were ranged the moisture contents of mortadella products (57.9 to 66.6). Guerra., *et al.*,(2011), the processing formula with 20% fat added had a higher moisture percentage (59.0) compared with the value in this study in all products (A, B, C, and D).The processing formula with 30% fat added had a lower moisture percentage (50.50%) compared with the moisture value of mortadella products (A, B, C, and D). The results indicate that the fat values were significantly different (P<0.01) among the mortadella products. The fat content for sample (A, C, and D) comply with Sudanese

standards and metrology organization (SSMO, (2008) but sample (B) does not comply with requirements specified in the (SSMO, (2008). Also the treatment were significantly different ($P < 0.01$) in Ash (%). mortadella B (2.40) had lower ash content compared with the mortadella product C

(3.80). In this study, the Ash content in the products (A (2.50), B (2.40), and D (2.80)) are in agreement with Mariusz., *et al.*,(2011) but sample (C, 3.80) different, they must be (1.99 to 2.80). With regard the protein content.

Table (1) chemical composition of Mortadella products processed by four different industries

| Item | A(mean±SD) | B(mean±SD) | C(mean±SD) | D(mean±SD) |
|------------|---------------------------|--------------------------|--------------------------|--------------------------|
| Moisture % | 52.10 ^a ±7.57 | 55.80 ^a ±4.62 | 58.50 ^a ±6.71 | 55.80 ^a ±2.06 |
| Fat % | 25.75 ^a ±2.75 | 28.0 ^a ±1.41 | 17.15 ^b ±4.79 | 17.57 ^b ±2.59 |
| Ash % | 2.50 ^b ± 0.7 | 2.40 ^b ± 0.22 | 3.80 ^a ±0.2 | 2.80 ^b ±0.44 |
| Protein% | 17.8 ^a ±2.28 | 19.00 ^a ±2.21 | 19.30 ^a ±1.15 | 19.60 ^a ±1.46 |
| Energy | 301.8 ^{ab} ±34.4 | 316.7 ^a ±15.7 | 231.7 ^c ±43.2 | 244.2 ^{bc} ±7.5 |

^{abc}Means with the same row with different superscripts differ significantly ($P \leq 0.05$).

A ,B,C,D Mortadella samples of four different companies

SD standard deviation

The protein levels decreased with increased lipid percentages and the consequent reduction in the levels of goat meat added, protein values in the three formulations were in accordance with Brazilian legislation, which requires that the mortadella contain $\geq 12\%$ protein ([Brazil, \(2000\)](#)).

Table (1) also revealed that energy values were significantly differ ($p < 0.01$) among the treatments. Mortadella C (231.7) had lower value compared with Mortadella B (316.7). The higher energy value of mortadella B (316.7) could be attributed to its higher fat content and to the fact that fats provide more than twice energy than that supplied by protein or carbohydrates (Giese, J., (1996). The result of physical characteristics (table 2) showed that treatments were significantly different ($p < 0.05$) in pH values, and W.H.C. Mortadella D (6.19) had a higher value compared with the

Mortadella C (5.68). Also Mortadella D (1.37) had a higher value compared with Mortadella B (0.48) in W.H .C. The pH value obtained in present study in groups A (6.07), B (5.97), C (5.68), and D (6.19) and W.H .C in sample A(0.61),B (0.48),C(0.74), and D(1.37) were similar with results of Mariusz., *et al* (2011) who reported pH (in range 5.88 to 6.34) and W.H. C (in range(0.28 to 1.5). Mortadella products samples (table 2) which stored at - 18 °C for a month were statistically similar ($P > 0.05$) in storage loss%. Mortadella D (5.80) had a lower value compared with Mortadella C (8.67). During freezing storage and thawing, meat loses water by evaporation, sublimation, and exudation, respectively; moisture is also lost during cooking. Moisture losses by evaporation during freezing of non-packed carcasses or joints normally amount to between 0.5 and 1.2% of the total weight (Genot, 2000).

Table (2) Physical characteristics of Mordella products processed by four different companies

| Item | | A(mean±SD) | B(mean±SD) | C(mean±SD) | D(mean±SD) |
|----------------|-----|--------------------------|--------------------------|--------------------------|--------------------------|
| pH | | 6.07 ^a ±0.1 | 5.97 ^{ab} ±0.22 | 5.68 ^b ±0.28 | 6.19 ^a ±0.1 |
| W.H.C | | 0.61 ^{ab} ±0.21 | 0.48 ^b ±0.18 | 0.74 ^{ab} ±0.07 | 1.37 ^a ±0.89 |
| Storage .loss% | | 5.95 ^a ±1.22 | 6.34 ^a ±3.89 | 8.67 ^a ±2.39 | 5.80 ^a ±1.89 |
| Colour | a* | 13.52 ^a ±2.23 | 13.10 ^a ±2.59 | 12.17 ^a ±3.13 | 12.20 ^a ±3.60 |
| | b * | 7.15 ^b ±0.25 | 9.12 ^a ±0.94 | 6.80 ^b ±0.38 | 9.27 ^a ±0.86 |
| | L* | 38.02 ^b ±0.72 | 42.10 ^a ±1.30 | 36.12 ^b ±1.50 | 38.6 ^b ±1.78 |

^{abc}Means with the same row with different superscripts differ significantly ($P \leq 0.05$).

A ,B,C,D Mortadella samples of four different companies

SD standard deviation

W.H.C. water holding capacity

a* = redness

b* =yellowness

l* = lightness

Color values of different Mortadella products shown in table (1). The values were significantly the same ($p < 0.05$) among Mortadella products. Except yellowness (b*) of mortadella products were significantly different ($P < 0.01$). Mortadella D (9.27) had a higher value compared with mortadella C (6.80). lightness (L*) values also were significantly different ($p < 0.01$). Mortadella B (42.10) had a higher value compared with mortadella C (36.12). In this study, the redness value a* (in range 12.17 to 13.52)

were similar with results of Mariusz. ,*et al* (2011) , who observed corresponding values of parameter a* (11.02 to 16.55) , but values of parameter b* (in range 7.15 to 9.27) and values of parameter L* (in range 36.12 to 42.10) were lower than of Mariusz ., *et al*(2011) ,who observed corresponding value parameter b* (in range 6.43 to 10.64) and parameter L* (in range 52.29 to 68.01). That might be referring to formula ingredients beside the different animal tissues between beef and pork.

Table (3) Peroxide, Acid, and Sodium chloride values and microbiological quality of Mordtalla products processed by four different companies in Sudan

| Item | A(mean±SD) | B(mean±SD) | C(mean±SD) | D(mean±SD) |
|-------------|-------------------------|-------------------------|-------------------------|-------------------------|
| P.V | 0.48 ^a ±0.10 | 0.60 ^a ±0.14 | 0.64 ^a ±0.16 | 0.60 ^a ±0.2 |
| A.V | 1.86 ^a ±1.38 | 2.06 ^a ±1.20 | 2.08 ^a ±1.47 | 1.72 ^a ±1.19 |
| Nacl | 1.58 ^a ±1.08 | 1.53 ^a ±1.72 | 1.79 ^a ±3.51 | 1.57 ^a ±2.53 |
| T.V.C Log10 | 5.41 ^a ±27 | 6.08 ^a ±1088 | 6.2 ^a ±1178 | 6.7 ^a ±8433 |

^{abc}Means with the same row with different superscripts differ significantly ($P \leq 0.05$).

A ,B,C,D Mordella samples of four different companies
SD standard deviation
P.V = Peroxide value
A.V = Acid value
Nacl = sodium chloride
T.V.C= total viable bacteria count

Peroxide value and Acid value

The results of peroxide value and Acid value in table (3) were significantly in similar value ($p > 0.05$) among the treatments. The peroxide value is a useful method to determine the early stages of fat oxidation and the product is considered rancid when (P.V) of 20-40 meq / kg is reached (Economou, *et al.*,1991). In this study the peroxide values of Mortadella samples in the range (0.48-0.64) which in agreement with that of (Hemin, 2013).

The sodium chloride (mg / 100g) values of Mortadella products (table 3) were statistically equal ($p > 0.05$) among products. The sodium chloride in this study were similar with the finding of (Guerra ., *et al* 2011) who observed corresponding values of Nacl in the range of (1.73 to 1.89) and lower than Mariusz. *et al* ,(2011) who observed corresponding values of NaCl in the range of (1.98 to 2.45). Minimum salt concentrations of 1.4 % or 1.75 % for

normal and low fat products, respectively, are required to achieve acceptable product bind and quality (Ruusuen and Puolanne., 2005). Total viable bacterial count as colony forming unit/gram (log 10 cfu/g) for Mortadella products samples were significantly similar ($p > 0.05$) among the Mortadella groups table (3). Bacterial growth was assessed in two dilution's 10^{-4} and 10^{-5} . 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) contamination could happen during production, processing or distribution. The excellent microbiological quality of Mortadella was due to the quality of raw materials used, in combination with good production practices in preparing the products, which efficiently maintain quality and safety of the mortadella (Guerra. *et al.*, 2011).

Table (4) sensory attributes of Mortadella products in Khartoum markets

| | A | B | C | D |
|-----------------------|--------------------------|--------------------------|-------------------------|--------------------------|
| Colour | 6.00 ^a ±1.20 | 6.50 ^a ±1.16 | 5.41 ^a ±1.24 | 6.33 ^a ±1.07 |
| Flavor | 5.91 ^a ±2.02 | 5.75 ^a ±1.76 | 4.75 ^a ±1.35 | 5.75 ^a ±1.05 |
| Juiciness | 6.08 ^a ±1.31 | 5.58 ^{ab} ±1.24 | 4.33 ^b ±0.98 | 5.41 ^{ab} ±1.92 |
| Tenderness | 5.91 ^a ±1.50 | 5.58 ^{ab} ±1.62 | 4.08 ^b ±1.67 | 6.33 ^a ±1.07 |
| Overall acceptability | 5.66 ^{ab} ±1.92 | 5.58 ^{ab} ±0.99 | 4.25 ^b ±1.42 | 6.16 ^a ±1.11 |

^{abc}Means with the same row with different superscripts differ significantly ($P \leq 0.05$).

Table (4) revealed that the color, and flavor values were significantly similar ($p \geq 0.05$) among the all Mortadella products.

Mortadella product of treatment C showed significantly lower juiciness, tenderness, and overall acceptability values ($P < 0.05$, this

could be attributed to its higher moisture content and lower fat content. however treatment B showed significantly higher overall acceptability ($P < 0.05$), this might be to its higher fat content. These findings support the assumption of Guerra., *et al* (2011) who indicated that the Consumer panelists detected significant sensory differences ($P < 0.05$) among the three goat mortadella formulations. These products were rated in the range of 6.0–7.6, indicating that goat mortadella was well liked. Addition of fat had a significant effect ($P < 0.05$) on all sensory parameters of mortadella. The scores for appearance, colour, odour, flavour and total acceptance were higher in the formulation with 10% fat added with compared 20 and 30%.

Conclusion:

It was concluded from this study that:

1. The mortadella from different meat Industries Company in Sudanese local market in this study comply with legislative demands concerning Microbiological and physico-chemical parameters.
2. Fat% in mortadella (B) exceeded the maximum limit level of 25 %.
3. The Mortadella (D) had the highest percentage of protein, and was preferred by the panelists, whereas Mortadella (A),and (B) respectively after (D),but Mortadella (C) was disliked extremely by the panelists.

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تقييم منتجات اللحم المدخن المرتدلا في أسواق الخرطوم

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المستخلص

صممت هذه الدراسة لتقييم الخصائص الكيموفيزيائية و الخواص الحسية و الجودة الميكروبية لمنتجات اللحوم المدخنة (المارتديلا) في الأسواق المحلية بالسودان ، جمعت العينات عشوائيا و المصنعة بواسطة أربعة مصانع مختلفة في السودان. تم تحليل التباين بعرض البيانات باستخدام برنامج (SAS). النتائج أوضحت أن منتجات اللحوم المدخنة (المارتديلا) في الأسواق المحلية السودانية لأربعة مصانع لحوم مختلفة إنها إحصائيا متشابهة في محتوى الرطوبة %، البروتين %، فاقد التخزين ، رقم الأكسدة ، رقم الحموضة، كلوريد الصوديوم، العد البكتيري الحيوي الكامل. قيمة الـ pH ، قابلية حمل الماء، الدهن % ، الرماد % بجانب المحتوى الكامل للطاقة للمنتجات لها فروق معنوية ($P < 0.05$) خلال العينات المختلفة ، عرضت نتائج الخواص الحسية للمارتديلا و التي حددت بواسطة ذواقة، و إحصائيا متشابهة ما عدا في الطراوة، العصيرية، و التي اختلفت معنويا ($P < 0.05$) و يمكن تخيص أن منتجات المارتديلا للمصانع الأربعة المختلفة متشابهة في الكيموفيزيائية ، الخواص الحسية و الجودة ميكروبية عدا الدهن % و الرماد % و اصفرار و بياض اللون .