



## Study on Wholesomeness of Beef Sausage Processed by Butcheries in Khartoum State and Conformity to Sudanese Standards and Metrology.

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### ABSTRACT

This study was conducted in the College of Animal Production Science and Technology during the year 2012 to investigate the chemical composition, wholesomeness and the conformity of beef sausage in Khartoum state (Khartoum, Khartoum North, Omdurman) with the Sudanese Standard Metrology Organization Specifications. The results of the chemical composition revealed that the moisture percent was 68%, 62%, and 60% in Khartoum, Khartoum north and Omdurman samples respectively. The results revealed also that fat percent was 4.5%, 7.4% 11.9%, whereas the crude protein percent was 15%, 17.4% ,19.9 % .The ash percent was (1.08%, 0.98%, 0.87% respectively .The statistical analysis showed that there was significant difference  $p < (0.01)$  in moisture percent. Regarding fat, crude protein and there was significant difference  $p < (0.05)$  between the three markets. The bacterial assessment of the beef sausage samples in the three markets showed that the total bacterial count was  $16 \times 10^6$ ,  $2.67 \times 10^6$  and  $4 \times 10^6$  in Khartoum, Khartoum North, and Omdurman respectively. The statistical analysis of T.B.C revealed that there was significant difference ( $p < 0.05$ ) in the samples of the three markets .The bacteriological analysis showed higher contamination with salmonella and *E. coli* in Khartoum samples compared with those of Khartoum north and Omdurman. The percentages of contamination of samples in three markets with salmonella and *E. coli* were 66.6% and 77.7% of the total samples respectively. The statistical analysis revealed that there was no significant difference at ( $p < 0.05$ ) between samples collected from the three markets in contamination with Salmonella in and *E. coli*. The study concluded that the chemical composition and wholesomeness of the beef sausage produced in the three markets were not matching with Sudanese standards metrology and organization specifications (2010).

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### INTRODUCTION:

Among African countries, Sudan is characterized by diverse animal resources including cattle, sheep, goats and camel.

Meat animals in Sudan depend mainly on the natural grazing system which affects meat production (Abugroun, 2000). Sudan

has a huge livestock population, estimated to be more than one hundred and forty million heads and classified as follows: 51million sheep, 43 million goats, 41 million heads of cattle, and 4 million camels (MARF, 2009). Therefore, modern aspects of animal production efficiency based on recent scientific approaches must be considered, especially slaughtering and processing techniques with good control of sanitation and hygiene. These will result in greater yields and higher profits and would also provide incentives for increasing production (MARF, 2009). Meat and meat products are highly perishable and spoil easily and soon become unfit to eat and possibly dangerous to health through microbial growth, chemical changes and breakdown by endogenous enzymes (Judge *et al.*, 1989). The study carried out by (Adam *et al.*, 2010) reported that the microbiological quality of meat depends on the physiological status of the animal at slaughter, the spread of contamination during slaughter and processing, the temperature and other conditions of storage and distribution. In fact, some of the microorganisms originate; from the animals intestinal tract as well as from the environment with which the animal had contact at some time before or during slaughtering. Meat is the most valuable livestock product and for many people serves as their first-choice source of animal protein. In 2002, under the advice of the expert panel on microbiological safety of food, microbiological guidelines were made for ready-to eat food, these guide lines stipulate the safety limits of nine major food borne pathogen such as *Salmonella* species, *E. coli* O157 and *Vibrio cholera*, as well as providing classification of microbiological quality of ready-to-eat foods for reflecting the hygienic status of the foods concerned (Microbiological Guidelines for Ready-to-eat Food 2007). The process of preserving meat by stuffing salted, chopped meat

flavoured with spices into animal casings dates back thousands of years, to the ancient Greeks and Romans, and earlier. The word “sausage” is derived from the Latin word “salsus”, which means salted, or preserved by salting. Sausages and sausage products have since evolved into a wide variety of flavours, textures, and shapes resulting from variations in ingredients and manufacturing processes (William 1999).

The (FAO 1985) views sausages as one of the oldest forms of meat processing in which meat go through various modification processes to acquire desirable organoleptic and keeping properties. Sausage referred to as a product prepared with ground or finely comminuted meat and meat by-products, usually seasoned with spices, seasoning and flavourings, and containing water and fat in varying amounts. The objectives of this study are summarized as followings:-

- Study of nutritional quality of sausage produced by butchers in Khartoum state.
- Study of the chemical and microbial safety of such sausage.
- Study the conformity of sausage produced by butcher in Khartoum state with the SSMO (Sudanese standard metrology organization specifications) (2010).

## **MATERIALS and METHODS**

The study was conducted at the laboratory of Meat Science and Technology, College of Animal Production Science and technology, Sudan University of Science and technology from 10/2012 to 1/2013. The samples of beef sausage were randomly collected from different butcher shops in Khartoum state (Khartoum, Khartoum north and Omdurman). The total number of samples collected were nine samples (three samples from each location).

### **Chemical composition:**

### **Proximate analysis:**

Determination of the total moisture, crude protein (CP), ether extracts (EE) and ash of the beef sausage samples were performed according to A.O.A.C (2002) procedure.

### Moisture Determination:

Moisture content was based on weight loss of 5 gm of samples. The samples were put in an oven at 100°C for 24 hours. Consequently the samples were cooled in desiccators and their weights were determined. The moisture content was calculated according to the following equation:

Moisture% =

$$\frac{\text{Fresh sample weight} - \text{dried sample weight}}{\text{Fresh sample weight}} \times 100$$

According to the method of A.O.A.C (2002).

### Fat Determination:

Fat was determined by ether extract. Two grams from the samples were taken to Soxhlet apparatus. The samples were subjected to continuous extraction with ether for 5 hours. The sample was then removed to the extractor and allowed to dry for 2 hrs at 100°C in a drying oven till no trace of ether remained. The samples were then cooled and weighted for ether extract percentage; the calculation was done as following:

$$\text{Fat \%} = \frac{\text{Fat weight} \times 100}{\text{Sample weight}}$$

According to the method of A.O.A.C (2002).

### Crude protein:

Kjeldhal method was used to determine nitrogen%. Crude protein was determined by multiplying the amount of nitrogen times 6.25. The fresh sausage samples were minced and 1 gm was digested in Kjeldahl flask by adding 10 gm of catalysts (Mercury) and 25 ml conc. H<sub>2</sub>SO<sub>4</sub>. The mixture was heated for 3 hours. The digested samples were cooled and then 100 ml of distilled water was added to each flask. 50 ml of boric acid containing methyl blue were placed

under condenser of each distilled unit. The mixture was then titrated against 0.1 N HCL. The formula used for calculation of Nitrogen was as follows: -

Nitrogen content % =

$$\frac{T_v \times N \times 14 \times 100}{\text{Weight of sample} \times 1000}$$

Where:

T<sub>v</sub> = Actual volume of HCL used for titration.

N = Normality of HCL.

14 = each ml is equivalent to 14 mg nitrogen.

1000 = to convert from mg to g.

6.25 = constant factor.

Protein content % = Nitrogen content % × 6.25

According to the method of A.O.A.C (2002).

### Ash Determination:

Two grams of fat free sample were placed into dried crucible of known weight. The crucible was placed inside a muffle furnace at 105°C. The temperature was increased gradually till it reached 600°C for 3 hrs. Then the crucible was taken out, cooled into desiccators and weighted. The ash percentage was calculated by the following formula: according to the method of A.O.A.C (2002).

Ash% =

$$\frac{\text{weight of crucible before ashing} - \text{weight of crucible after drying}}{\text{Sample weight}} \times 100$$

### Bacterial assessment

#### Total viable count:

Standard plate count media was used to determine the total bacterial count. The sample was prepared according to the technique described by ICMSF (1978). One gram from each sample was transferred under aseptic condition to glass tube containing 9 ml of sterile normal saline. The content of the tube was homogenized by

dipping and shaking the sample to have a dilution of  $10^{-1}$ . Such homogenate was used for all bacterial investigation. Further, fold serial dilutions were prepared up to  $10^{-5}$  (ICMSF 1978). about 10-15 ml of plate counter agar media poured aseptically into sterile Petri- dishes. One ml from dilutions was added to each Petri-dishes, and then they were transferred to an incubator at 37°C for 24 hours. A colony counter was used for counting colonies grown in the incubated Petri-dishes.

#### **Bacterial Isolation and Identification:**

For isolation of *Salmonella* spp. The samples were incubated in salmonella Shigella agar plate and incubated at 37°C for 24 hours. Well isolated individual colony of different types were sub-cultured on fresh agar for purification. For isolation of *E. coli* form bacteria the samples were incubated on Mac-Conkey agar and incubated at 37°C for 24 hours and colonies of different morphology were sub-cultured, purified and identified (ICMSF 1978).

#### **Statistical Analysis:**

Data obtained was subjected to analysis of variance using computer program system Statistical package of Social Science (SPSS) (Version 16.0). Means were compared using least significant difference (LSD) Procedure as outlined by (Steel and Torrie 1980) and one sample t test was used.

#### **RESULTS and DISCUSSION:**

The chemical analysis in table (1) showed that there was high significant differences ( $P < 0.01$ ) in the moisture. Fat, crude protein and ash percentage were showed significant difference ( $p < 0.05$ ) in the three locations of Khartoum state samples. The results of chemical analysis of the sausage samples from the three locations (Khartoum, Khartoum North and Omdurman) revealed that moisture content was 68%, 62%, 60% in Khartoum, Khartoum North and

Omdurman samples respectively. The fat percent was 7.4%, 4.5%, and 11.9 % in the three locations respectively. The crude protein content was 15% in Khartoum, 17.4 % in Khartoum north and 19.9% in Omdurman. The ash% was about 1.08% in Khartoum, 0.98% in Khartoum north and 0.87% in Omdurman.

#### **Moisture content:**

The moisture percentage in Khartoum was higher than other locations (Khartoum north and Omdurman). These results agree with Alexandra *et al.*, (2009) who pointed-out that, the amount of moisture content in the beef sausage is 61.5%, also agree with Schönfeldt *et al.*, (1996), who reported that the moisture content in raw beef sausage as 61% and similar to (SSMO, 2010) limits as the ice and water added should not exceed 10% of the final product. The SSMO reported that the moisture content from standard should not be less than 52% in fresh sausage (SSMO, 2010). Similarly G.S.O. (2008) limits (50%) were matched with present results. The result also matched with Abul-Fadl (2012) who mentioned that the moisture content of fresh beef sausage is 60.8%, but disagreed with Agnihotri, (2002) who reported the fresh sausages moisture content as 48-55%.

#### **Fat content:**

Ether extract in this study was 4.5 %, 7.4% and 11, 9% in Khartoum, Khartoum North and Omdurman respectively. There was significant difference ( $p < 0.05$ ) between three locations. However, Omdurman samples recorded a higher percentage of fat than that of Khartoum and Khartoum north samples. The results of this study were in agreement with Egbal (2007), who reported that the fat content in *Looli*, *AL-gousi* and Locally (*Butchery*) processed sausage was 7.01% , 4.67% and 4.09% respectively. These results were less than SSMO(2010) limits as not exceeding 25% of fat in the

final product and G.S.O. (2008) limits less than 35%. The results disagree with Dharmaveer *et al.*, (2007) who mentioned fat content was 16.7% in fresh sausage.

#### **Crude protein:**

Protein content of this study was 15%, 17.4% and 19.9% in Khartoum, Khartoum north and Omdurman respectively. There was significant difference ( $p < 0.05$ ) between the three locations. However, Omdurman had higher protein content than other locations. The results agree with SSMO (2010) limits as not to be less than (15%). GSO (2008) limits stated protein content should not be less than (16.67%). The present result was little less than that of Jihad *et al.*, (2009), who figured out that the protein percent of seven type of sausage produced in Jordan was 12.1% and 14.4%.

#### **Ash content:**

As table (1) illustrated, the ash content of this study was 1.08%, 0.98% and 0.87% in Khartoum, Khartoum north and Omdurman respectively. The results showed that there was significance difference ( $p < 0.05$ ) in ash content between three locations. Khartoum showed high percentage of ash (1.08%) than Khartoum north and Omdurman. These results disagree with. Pal and Agnihotri (1996) who reported that the ash content of chevon sausage was 2.06-2.21%, and less than Dharmaveer *et al.*, (2007) who reported that the ash content of smoked chevon sausage as 3.00%. The ash content of this study was less than the findings in Looli 1.9%, *AL-gousi* 2% and locally (*Butchery*) processed sausage 1.5% Egbal, (2007). The result disagreed with GSO (2008) limits ash content 1.5%.

#### **Bacterial assessment:**

##### **Total viable count-**

Table (2) showed that the total bacterial count in Khartoum samples ( $16 \times 10^6$ ) cfu/g

cfu/g, Khartoum North samples ( $2.67 \times 10^6$ ) cfu/g and Omdurman samples ( $4 \times 10^6$ ) cfu/g. The results showed that there was significance difference ( $p < 0.05$ ) cfu/g between three locations. Khartoum samples recorded higher total bacterial count ( $16 \times 10^6$ ) cfu/g than that in Khartoum north and Omdurman. These results were not inline with (SSMO, 2010) specifications as ( $2.25 \times 10^5$ ) cfu/g and the British Meat Processors Association (2011) which reported the microbial standard of raw sausage and sausage stuffing as  $< 5 \times 10^5$  cfu/g. Also the result disagreed with Lamy *et al.*, (2012) who reported that the local processed fish sausage has total viable counts (TVC) of ( $4 \times 10^3$  -  $6 \times 10^5$ ) cfu/g.

##### **Sausage contamination:**

Table (3) showed contaminations of sausage samples with salmonella and *E. coli* in Khartoum state. The contaminants of sausage samples revealed 66.6% positive to salmonella. The samples also showed 77.7% positive to *E. coli*. There were no significant differences between three locations in contamination with salmonella and *E. coli*. This result was not matched with that of Lamy *et al.*, (2012) who reported that the local processed sausages provide low contamination with microbes as *Escherichia coli* (19.71%), *Listeria monocytogen* (18.82%), *Salmonella* (16.47%) and with SSMO specifications (2010) who stated the fresh beef sausage samples should be free of *Salmonella* and *E. coli*.

##### **Conclusion**

This study was concluded to:-

- All samples in Khartoum butcher shops were highly contaminated.
- All samples in Khartoum state were contaminated with *salmonella* and *E. coli*.

## REFERENCES:

- Abugroun, H. A. (2000). Factors affecting quality of Sudanese meat and meat product. Seminars of the Arabic Organization for agricultural development, Khartoum.
- Abul-Fadl, M.M. (2012). Nutritional and chemical evaluation of white cauliflower. By-product and the effect of its addition on beef sausage quality. *Journal of Applied Sciences Research*; **8**(2): 693.
- Adam, Y.S.I. and Abugroun, H. A. (2010). Effect of Sudanese marketing condition on quality attributes of meat products. *Pakistan Journal of Nutrition*. **9** (12):1149-1156.
- Agnihotri, M.K. and Pal, U.K. (2000). Quality of chevon sausage in refrigerated storage. *Indian Journal of Animal Science*, **14**:69 -73.
- Alexandra, S., Silvia, A., Ueli, B., Daniel, S., René, B. and Ruedi, H. (2009). Nutrient composition of Swiss cooked sausages. *Fleischwirtschaft* **89**(10): 98-102.
- A.O.A.C (2002). Association of official Analytical Chemists. (15<sup>th</sup>ed.). Washington, DC.
- Britishmeat processor Association. British Quality Assured Pork Sausage (2011). Processing standards and product specifications for the production of British Quality Assured Pork Sausage 12 Cock Lane London .EC1A 9BU. Email: [info@bmpa.uk.com](mailto:info@bmpa.uk.com). Website: [www.bmpa.uk.com](http://www.bmpa.uk.com) Revision 8.
- Dharmaveer, S., Rajkumar, V., Mukesh, K. P. (2007). Quality and shelf-life of smoked chevon sausages packed under vacuum and stored at 4±1°C. *American Journal of Food Technology*, **2**:238-247.
- Egbal, S.A. (2007). A study on the chemical composition and microbial contamination of locally processed sausage. Sudan University of science and technology.
- FAO, (1985). *FAO Animal production and Health paper 52: Small scale sausage production*. I. V. Savic (Ed.). Food and Agriculture Organisation of United Nations, Rome, Italy.
- G.S.O. (2008). Gulf Standard Organizations; standardization Organization for G.C.C, prepared meat dry and semi dry fermented sausage GSO/FDS.108.
- ICMSF (1978). Microorganism in foods, their significance and methods of Enumeration 2<sup>nd</sup> Ed, University of Toronto, press, Toronto and Buffalo, Canada.
- Jihad, M. Quasem; Aman Silliman Mazahrech and Ali Fleh-AL-Shawabkeh (2009). Nutritive value of seven varieties of meat products (sausage produced in Jordan). *Pakistan journal of Nutritional*; **8**(4): 332-334.
- Judge, M., Aberle, E., Forrest, J., Hedrick, H., & Merkel, R. (1989). Principles of meat science (2nd ed.). Iowa: Kendall/Hunt Publishing Company. Dubuque, Iowa USA. (97-133).
- Lamya, E.L. Sediek; Wafaa, M.M. Abozeid, Dalal H. Alkhalifah and Serag E. A. Farag (2012). Efficacy of ginger extract (*Zingiber Officinale*) and gamma irradiation for quality and shelf-stability of processed frozen beef Sausage. National Centre for Radiation Research & Technology, P.O. Box 8029, Nasr City, Egypt.
- MARF (2009). Ministry of Animal Recourses and Fisheries. Animal census.

Microbiological guidelines for ready-to-eat food (2007). Risk Assessment Section, Centre for Food Safety, Food and Environmental Hygiene Department, 43/F, Queensway Government Offices, 66 Queensway, Hong Kong.

Pal, U.K. and Agnihotri, M.K. (1996). Effect of vegetable oil on the quality of fresh chevon sausage. *Journal of Applied Animal Research*, 9:187-191.

Schönfeldt, H. C., Visser, R.E., van Nierkerk, J.M. & Van heerden, S.M. (1996). The nutritional content of South African beef. Meat industry centre, livestock business division, Irene Animal

Production Institute. Irene, Republic of South Africa:18.

SSMO (2010). Ministry of cabinet affairs, Sudanese standards and metrology Organization; Sudanese standard fresh sausage SDS295 (2010).

Steel, R.G.D. and Torrie, J.H. (1980). Principles and procedure of statistical. A biomedical approach. McGraw-hill, New York.

William, J. Hudnall (1999). Safe Practices for Sausage Production Room 2932-South Building; 1400 Independence Ave. S.W. Washington, D.C. 20250.

Table 1: Chemical composition of sausage samples in Khartoum state.

Locations	Moisture%	Fat%	CP%	Ash%
Khartoum	68±1.2 <sup>a</sup>	4.5±75 <sup>b</sup>	15±.67 <sup>b</sup>	1.08±1.08 <sup>a</sup>
Khartoum-north	62.4±.11 <sup>b</sup>	7.4±.16 <sup>b</sup>	17.4±.20 <sup>b</sup>	0.98 ±0.00 <sup>b</sup>
Omdurman	60±2.45 <sup>b</sup>	11.9±34 <sup>a</sup>	19.9 <sup>a</sup>	0.87±0.02 <sup>b</sup>
Std. Error	1.3	1.3	0.82	0.036
Significant	**	*	*	*

\*\* Significant at (p<0.01).

\* Significant at (p<0.05).

a, b. mans within the same column followed by different subscripts are significantly p(<0.05) different .

Table 2: Total viable count (CFU/g) in the sausage samples of different locations in Khartoum state.

Locations	TVC(CFU/g)
Khartoum samples	16±8×10 <sup>6a</sup>
Khartoum North samples	2.67±1.15×10 <sup>6b</sup>
Omdurman samples	4±2×10 <sup>6b</sup>
Std. Error	2.53×10 <sup>6</sup>
Significance	*

\* Significant at (p<0.05).

a,b means within the same Column followed by different subscripts are significantly as different at p(<0.05)

Table 3: Contamination of sausage samples with Salmonella and *E. coli*

<b>Locations</b>	<b>Salmonella</b>	<b>E. coli</b>
Khartoum samples	+ve	+ve
Khartoum North samples	+ve	+ve
Omdurman samples	+ve	+ve
Std.Error	0.15	0.17
Significant	NS	NS

NS: The mean is not significant