Sudan University of Science and Technology (SUST) College of Graduate Studies

Quality Attributes in Some Factories of Beef Frankfurter in Khartoum State - Comparative Study

سمات الجودة في بعض مصانع الفرانكفورتر البقري في ولاية الخرطوم

- دراسة مقارنة

By

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DETECATION

To my dear supervisor

To my dear parents and family

To my dear friends and colleagues

To my husband,

I dedicate this work, with sinecure pleasure and respect

Acknowledgement

Thank God Almighty for having helped complete my work. Many thanks and respect to my supervisor Professor Maha Mubarak Mohammed,whose recommendations and untiring efforts helped me a lot in completing this work. Many thanks to Professor Mohammed taj Aldeen and all the technicians at the Department of Meat Science and Technology, Sudan University of Science and Technology .

I would also thank my family, and my dear husband for having encouraged me all the way, until the work has come to light complete.

And thanks go to the pioneers of the red meat industry in Sudan.

Abstract

The study was conducted in the college of Animal production, Sudan University of science and Technology. During the period from October to November 2015 to investigate some quality attributes and conformity of Frankfurter Beef sausage in Khartoum state (Bahri, Khartoum, and Omdurman), with Sudanese Standard Metrology Organization Specifications. The results of the study showed that there was a high significant difference ($p \leq 0.01$) among the locations of collection. Samples from Omdurman recorded highest moisture, Fat, and Ash (67.67%, 5.74%, 3.47%) respectively, whereas samples from Bahri recorded highest content of protein (25.57%). The Physical parameters of beef frankfurter showed high significant differences ($p \leq 0.01$) among the Khartoum, Bahri and Omdurman samples. Samples from Omdurman reported the highest value of water holding capacity (2.22), while there were no significant differences among the samples collected from Khartoum State in pH value and cooking loss%. Sensory evaluation results showed high significant differences ($p \leq 0.01$) in color and juiciness between the location samples. Samples from Omdurman reported the highest score of color and juiciness (4.57), (4.77) respectively. There were no significant differences between the samples collected from Khartoum State in Texture, Flavor. There was no significant difference between the samples collected from Khartoum State in total bacterial count.

ملخص الدراسة

اجريت هذه الدراسة في كلية الانتاج الحيوني، جامعة السودان للعلوم والتكنولوجيا- خلال الفتره من اكتوبر الي نوفمبر 2015 لتحقيق من بعض صفات الجودة ومطابقة السجق فرانكفورتر البقري في ولاية الخرطوم (بحري، الخرطوم، وأم درمان)، مع المواصفات والمقاييس السودانيه .أظهرت نتائج دراسة التحليل الكميائي أن هناك فروقات معنوية ($P<0.01$) بين العينات ولايه الخرطوم . سجلت العينات المأخوذه من أم درمان أعلى معدل الرطوبة، الدهون، الرماد (67.67%، 5.74 % ، 3.47 %) على التوالي، في حين سجلت العينات المأخوذه من بحري أعلى محتوى من البروتين (25.57%) . وأظهرت النتائج الفزيائيه الفرانكفورتر البقري فرقاً معنوياً جدا ($P<0.01$) في مسك الماء ، ام درمان سجلت أعلى قيمة من القدرة على الاحتفاظ بالمياه (2.22)، بينما لا توجد فروق معنوية بين العينات التي تم جمعها من ولاية الخرطوم في قيمة الرقم الهيدروجيني وفقدان الطبخ٪ .وأظهرت نتائج التقييم الحسي فرقاً معنوياً ($P<0.05$) في اللون والعصيرية بين عينات المواقع الثلاثه .سجلت العينات الماخوذه من ام درمان أعلى درجة من اللون والعصيرية (4.57)، (4.77) على التوالي .في حين لا توجد فروق معنوية بين العينات التي تم جمعها من ولاية الخرطوم في الملمس والنكهة .لم يكن هناك فرقاً معنوياً بين العينات التي تم جمعها من ولاية الخرطوم في العدد الكلي للبكتيريا.

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Chapter One

Introduction

Sudan is situated in northeast of Africa, lying between latitudes 40º and 22º North and longitudes 22º and 380º East. The country is traversed by the River Nile and its tributaries which have varying influences on irrigated agriculture and livestock production systems. In recent years, there has been an increased demand for convenience meat and meat products requiring minimal home preparation (Stubbs *et al*., 2002).

Meat and meat products are concentrated sources of high quality protein, and their essential amino acids content usually compensates for deficiencies in diets made mainly of cereals and other vegetable proteins. They supply easily absorbed iron and assist in the absorption of iron from other foods as well as zinc, and are rich sources of some of the B-vitamins. By providing such nutrients, meat consumption can alleviate common nutritional deficiencies (Abdel Moneim *et al.*, 2012).

Meat emulsions such as frankfurters and bolognas are finely comminuted and cooked products composed of water, muscle proteins, fat particles, salt and small amounts of non-meat ingredients, where meat proteins serve as natural emulsifier. In this group of processed meat products, fat and protein concentrations and their chemical interactions, especially those occurring during the emulsification process, exert a marked impact on the quality of the final product as they affect emulsion stability. Meat emulsion

stability and cooking losses depend on fat stabilization by proteins (Gema Nieto, *et al* .2011).

Meat factories are concentrated in Khartoum state, there are about 16 factories. But actually about 15 active factories distributed in three localities: Khartoum locality 8 factory, Omdurman 3 factory and Bahri 5 factory (Asama, H.A2014).

Meat quality is defined as the combination of physical, structural and chemical characteristics of meat which result in maximum desirability from the stand point of appearance and eatability (Pearson, 1960). Meat quality includes tenderness, palatability, aroma, flavor, color and juiciness (Kerry *et al*. 2002).

The objectives of this study are:

1- To evaluate the quality attributes and microbiological properties of Beef Frankfurter sausages in Khartoum State.
2- To study whether the Beef Frankfurter sausage meats the approves specifications of Sudanese Standards and Metrology Organization (SSMO).

Chapter Two

2.0 Literature Review

2.1: Meat:

Meat is defined as those animal tissues, which are suitable for use as food. All processed or manufactured products, which might be prepared from tissues, are included in this definition. The processed meat products are defined as those in which properties of fresh meat have been modified by use of one or more procedures, such as grinding or chopping, addition of seasoning, alteration of color or heat treatment. Generally, meat processing developed soon after people became hunters (Rawia Ibrahim., 2010; Judge *et al.*, 1990).

2.2: Meat Consumption:

Meat is consumed by humans for variety reasons including taste, nutrient, prestige, tradition and availability (Rogowski, 1980). Meat in diet is an important source of protein which is not only of high biological value but for its amino acid components. The most important taste active component of meat is amino acids, peptides, organic, nucleotides and other flavor enhancer (Shahidi, 1989). Also it is good source of Iron and Zinc (Bender, 1992).

2.3: Sausage:

The process of preserving meat by stuffing salted, chopped meat flavored 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 flavors, textures, and shapes resulting from variations in ingredients and manufacturing processes.The sausage manufacturing industry must adhere to government standards for ingredients and processes. In addition, accurate labeling requirements ensure that the consumer is informed of the ingredients of a sausage product (FDA, 1999). Sausages are comminuted processed meat products made from red meat, poultry or a combination of these with water, binders and seasoning. They are usually stuffed into a casing and may be cured, smoked or cooked. The sausages as one of the forms of meat processing in which meats go through various modification processes to acquire desirable organoleptic and keeping properties (FAO 1985).

2.3.1: Types of Sausage:

There are six types of sausages: fresh sausages, uncooked smoked sausages, cooked smoked sausages, and cooked sausages, dry and semi-dry sausage (Boyle, 1994; Tronsky *et al*., 2011).

2.3.1.1: Cooked Sausage:

Made from meat which is ground, seasoned, often cured, stuffed into casings, cooked and no smoke is used. Cooked sausages are often served cold. Examples: branch weiger; liverwurst; liver cheese. Cooked sausage may be cured or uncured, are heat processed and sometimes smoked. They often contain a variety meat or organ meat such as liver (Boyle, 1994; Tronsky *et al*., 2011).

2.3.1.2: Cooked, Smoked Sausage:

Made from meat which are ground, seasoned, stuffed into casings, smoked and cooked. These can be eaten cold or reheated. Examples: bologna; Berliner; cotto-salami; frankfurters (Boyle, 1994; Tronsky *et al*., 2011).

2.3.1.3: Uncooked, Smoked Sausages:

Made from meat which is ground, seasoned, stuffed into casings, and smoked. These must be fully cooked before eating. Examples: some kielbasas, mettwurst; teawurst; smoked country-style pork sausage (Boyle, 1994; Tronsky *et al*., 2011).

2.3.1.4: Dry and Semi-dry Sausages:

Made from meat which are ground, seasoned, cured, stuffed into casings, fermented, often smoked, and carefully air-dried; true dry sausages are not cooked. These sausages have a distinctive tangy flavor due to the presence of lactic acid that is produced by fermentation. The meat is stuffed into casings and allowed to “ferment,” the process by which bacteria metabolize sugars and produce acids and other compounds as byproducts. In meat fermentation, bacteria which produce lactic acid are utilized to produce the tangy flavor of dry sausages. They are sometimes referred to as “summer sausages” and eaten cold. Examples: Pepperoni; German salami, Lebanon bologna, Genoa salami; thuringer; cervelat (Tronsky *et al*., 2011). Dry and semi-dry sausages are cured and sometimes smoked before the sausage is dried. These sausages have a tangy flavor due to a controlled bacterial fermentation or the addition of acids. Dry sausages are dried for a longer period of time than semi-dry sausages and are generally not heat processed. Uncut dry

sausages should be stored in a cool, dry place. Semidry sausages, such as summer sausage, are usually heat processed and should be stored refrigerated (Boyle, 1994; Tronsky *et al*., 2011).

2.3.1.5: Specially Sausage:

This is a diverse category that may contain cured, uncured, smoked, and non-smoked meats that do not readily "fit" into the other categories. They are seasoned and often formed into loaves. Examples: olive loaf; head cheese; jellied corned beef; scrapple; souse (Boyle, 1994; Tronsky *et al*., 2011).

2.3.2: Ingredients in sausage making:

2.3.2.1: Beef Meat:

Although all type of beef are suitable for sausage making; one of the most difficult problems for a sausage maker is to choose satisfactory beef at a reasonable price, Mange sausage products can be ruined if the sausage maker uses the wrong grade or wrong cut or improper processing, Well selected and well prepared beef is essential if the sausage – maker and consumer are to be satisfied (Isidor *et al*., 1972). Beef quality is, in general, determined by large number of interdependent extrinsic and intrinsic factor such as breed, condition, sex, exercise, pre-slaughter, treatment, slaughter condition and finally, methods of handling, chilling, and degree of aging (Isidor *et al*., 1972).

2.3.2.2: Casings:

Casings, also known as skins, used in sausage manufacturing achieve their primary significance in portioning. They are broadly divided into two types, namely natural and artificial. Intestines of pigs or sheep are used in making natural casings. Most products made of natural casings come out with a curve after filling and cooking. Apart from providing the required sausage shape, casings also increase product shelf life by providing high moisture and oxygen resistance properties with a seal strength and density. Casings therefore contribute in minimizing product weight loss during cooking. Casing sizes for sausage vary tremendously. While some are as small as 17 mm others could be up to 38 mm diameter and 300 mm in length. A balance between high resistances to splitting coupled with easy dissolution in the mouth while eating is among the prime considerations in the choice of casing (Celia Bennett, 203).

2.3.2.3: Non meat ingredients (additives):

Seasoning are any ingredients which improve flavor and include spices, herbs, vegetables, nuts, and other substances (monosodium glutamate) etc, while enhancing favor, they stimulate the secretion of digestive juices. The most common sausage spice is pepper .other usual seasonings including spices are all-spice, bay leaves, Caedmon, cloves, coriander, and curry powder, garlic, ginger, and onion and pimento sage. In many factories liquid spices are used with considerable success (Isidor *et al*., 1972). Spices contribute so much to sausage flavor that standardization is necessary to control seasoning formulation. Besides contributing to flavor, spices provide in same

instance, bacteriostatic and antioxidant properties (Pearson and Tauber, 1984).

Binders and Extenders are non-meat proteins are widely used in meat processing .Non-meat proteins used in meat processing technology divided into two groups: (1)plat proteins such as soy isolates, Soy concentrates and flours (2)protein of animal origin such as milk protein, Soy protein have been used in meat processing to improve functional properties such as water binding and textural properties, they are hydrophilic (absorb and retain water) and have adhesive properties (Giese,1992;Dexter *et al.*,1993; Mittal and Parut,1993; Pietrasik and Duba,2000;Porcella *et al.*,2001; Dolata and Piotrowska,2002; Meltem and Meltem,2003).There is a wide variety of non meat products that meat processors can incorporate into sausage within the guidelines allowed e.g. under USDA meat inspection regulation in the USA. These products are referred to as binders or extenders and frequently as fillers, emulsifiers or stabilizers (Pearson and Tauber, 1984).

Water or ice added to the meat mass provides considerable functional qualities. The ice or water chills the meat during the chopping or mixing operation, which permits longer and more efficient churning of the meat mass without mechanical overheating. Added water aids in dissolving sodium chloride and curing salt to give better distribution in mass. Texture and tenderness of the finished sausage are markedly affected by the added water content (Pearson and Tauber, 1984). According to Sudanese Standards and Metrology Organization, (2008) the level of added water should not exceed then 10% in the fresh sausage.

Salt is the most common and most important non meat ingredient of sausage. Salt for sausage must be of food-grade quality. Salt (sodium chloride) serves three functions in sausage: first; it dissolves in water to form brine which acts to retard microbiological growth, second; it aids in solubilizing the myosin type protein of comminuted muscle for emulsifying the fat in emulsion sausage, third; it contributes basic taste characteristics (Pearson and Tauber, 1984). Salt is added for flavorings function at concentration between 2-3 % Fresh sausages generally have a lower salt level due to detrimental color effect s, 1.5 % salt in finished sausage works out satisfactorily for color and flavor (Baumgartner, 1985).

Nitrate and nitrite have to Federal meat inspection regulation state that the use of nitrite or nitrate, or a combination of both, shall not result in more than 200 p.p.m nitrite in finished products. The legal level permitted is sometimes less than the residual level allowed. This is evident in the case of the ¼ oz nitrite permitted in 100 Lb chopped meat, which is only 156 p.p.m at the time of formulation (Pearson and Tauber1984). As discussed by Aberle *et al.,* (2001) nitrite, either as a potassium or sodium salt, is used to preserve desirable meaty flavor, prevent warmed-over flavor, fix a bright reddish pink color and inhibit microbial growth, particularly outgrowth of C.botulinum spores. Sodium or potassium nitrates were the first compounds used for this purpose.

Ascorbates and erythorbates are chemicals used interchangeably in cured sausages to which nitrite has been added. They are active reducing agents that react with nitrite to accelerate the curing process. Ascorbate is derived from ascorbic acid (i.e. vitamin C) (Trotsky .I., *et al* 2000).

2.4: Beef Frankfurter:

This sausage originated in Frankfurt, Germany, and can be a combination of beef and pork, all pork, or all beef. They are cured, smoked and normally served hot (Tronsky *et al* 2005). The Frankfurter process takes advantage of the natural ability of the meat to absorb and retain water without the use of Rusk or other cereal binders. A large number of frankfurters finish off as an oven-cooked product with a variety of colors, sizes and flavors. The characteristic smoke flavor is achieved by adding natural or liquid smoke to the process, while the color could be obtained by dipping in a vat of the appropriate color (Celia, 2013). There are numerous different formulations for making frankfurter, but the basic constituent is, of course, beef or veal, which is responsible for forming the characteristic texture of the finished product. In factor the colloid and emulsion systems of finished frankfurters depend predominantly on the use of lean or veal meat. Therefore, frankfurter must be considered as beef sausage, although they very often contain pork and regularly contain pork fat (Lawrie, 1966).

Choice of meat: The beef or veal shall be strictly fresh carcass cuts, of a good commercial quality, firm, containing not more than 10% trim able fat. Frozen beef can also be successfully used. The trimmed lean meat should be practically free of sinews and gristle and entirely free from ligaments, cartilages and bones: shank meat, flanks, hanging tenderness and shirts may not be used (Isidor *et al.,* 1972). The selection of meat should ensure that about two– thirds of the lean component is meat of good water – binding capacity (Isidor *et al.,* 1972).

Formulation: A number of different suitable formulations for frankfurter sausage either skinless or in sheep casings (Isidor *et al.*, 1972). All meats should have a temperature not exceeding 5°C when placed in cutter. The lean meat should be ground through the 3mm. plate of mincer; the fat should be run through a 6mm. plate. It is advisable to grind the tripe and filler meats through a 2 mm. mincer plate. The grinding may be passed if lean is placed directly in a powerful silent cutter (Isidor *et al.*, 1972). The ground meats are, then placed in the cutter with salt in a half of ice, and when the water is taken up, the other curing ingredients and polyphosphate preparation, dissolved in warm water are added (Isidor *et al.*, 1972).

Stuffing: The emulsion is filled in suitable sheep or cellulose casing, 20 or 22 mm .in diameter, the stuffer horn and linking table should be clean .and if cellulose casings are used, the surface of table should be quite dry throughout the whole operation. Filling must be to full capacity; proper handling will eliminate air-pockets and "pops" due to the meat running too far back on the horn. The sausages are tied or linked by hand in length of 10 cm .if smoking is not done on the same day, i.e. if hung over night. The sausages should be washed under a water spray before entering the smoke house (Isidor *et al.*, 1972).

Smoking and cooking: The total time of smoking may vary according to the smoke house, but as general guide it should be between approximately 2.5 hours or until the desired color is obtained .The frankfurter should have a dark brown smoked color and finished appearance at the end of the smoking. If frankfurters are stuffed in cellulose casing, they are ready for stripping or peeling, but some

procedures prefer to chill them before. Under the combined effect of smoke and temperature, the soluble protein which come to the surface of the sausages are coagulated, and smooth surface, strong enough to preserve the sausage shape and necessary for good peeling characteristic, is formed (Isidor *et al.,* 1972). The smoked frankfurter were scaled at 70ºc to an internal temperature of 65ºc after which they were cooled to 15ºc under running top water and stored at 2ºc over night (Akweley *et al* 2012).

Packaging: Frankfurters can be packed using cellulose films or shrink wraps.

The packages should be uniform in size, shape, and weight in line with modern trends. With an attractive and accurate label (Isidor *et al.,* 1972).

2.4.1: Type of Frankfurter:

1. Hot dog

2. Beef veal chicken Frankfurter.

3. Fish Frankfurter. 4. Canned Frankfurter.

Hot Dog: Speaking very broadly a Hot Dog is a Frankfurter served hot with mustard in a sliced roll. In Great Britain, Hot Dog is hot frankfurter in hard crusted bread roll, laced with onions. In most countries there are special condiments for Hot Dogs, Americans use a large number of condiments ranging from very special blends of mustard to tomato ketchup, sawerkraut, etc. and enjoying great popularity as arrange of Hot Dog relishes prepared to a well proved recipe of pickles, onion, peppers, vinegar, sugar, a special mustard, salt, alum, flavoring,

spices and turnips In Europe, French and German mustard are popular with Hot Dogs. There are three length of hot dog Frankfurter: 1.10cm Length 2.1cm length and 3.Cocktail size, approximately 7.5 cm in length. The most common diameter is 20 mm (Isidor *et al.,* 1972).

Chicken Frankfurter: This Frankfurter only differs from the standard beef veal frankfurter in the inclusion of chicken meat (Isidor *et al.,* 1972).

Fish Frankfurter: The fish meat for use in Frankfurter is treated just as any other type of meat when making this product. The fish meat in amount not exceeding 30% does not lower the quality of finished Frankfurter and doses not contribute a (fishy) taste. If more than 30% fish is included, then the Frankfurter has to be called a fish sausage (Isidor *et al.,* 1972).

Canned frankfurter: Formulation: In this type the water dosage must not exceed 15 – 18 percent of ice water to be used in chopping process.

2.4.2: Nutritive value of Beef Frankfurter:

Meat is an excellent source of many nutrients, especially protein, B vitamins, iron and zinc. As a nutrient dense food, meat provides major nutritive contributions to the diet relative to the amount of calories it contains (Boyle, 1994). Red meat contains protein of high biological value and important micronutrients that are needed for good health throughout life. It also contains a range of fats, including essential omega-3 polyunsaturated fats (William, 2007). The nutritive value of 3 ounce cooked portion of lean beef containing 195 calories would provide

25 g of protein, 9g of fat, over one-third of the daily requirement for zinc and nearly 15% of the daily iron needs (Boyle, 1994; Fennema, 1996). The average amount of protein and calories for beef meat is 20% protein and 310 calories (FAO, 1989). USDA (2014) reported the nutrient composition of beef is179 Calories, 7.9(g) Fat, 3.0 Saturated Fat and 25 (g) Protein. Beef Franks are high in sodium and nearly all the calories come from fat. Frankfurter usually contains nitrites preservatives that are suspected of contributing to cancer (Isidor et al., 1972).

2.4.4: The Chemical composition of Beef Frankfurter sausage:-

The chemical characteristics of food are related to the product itself and refer primarily to the content of specific substances, which are important from the point of view of keeping quality, flavor, nutritional value (Abdel Moneim.2012). Gerardo *et al* .,(2*014*) reported that the chemical composition of frankfurter as; Moisture 57.76%, Protein 10.24%, Fat 17.80% and Ash 5.88%. Emel and Nalan (2014) found the proximate analysis of frankfurter as; Moisture 67.04%, Protein 17.1%, Fat 5.74% and ash 3.4%. Also Regina *et al* ., (2012) assessment the chemical composition of frankfurter as; Moisture 62.34%, Protein 14.26%, Fat 16.14% and ash 2.93%. Naral, H *et al*., (2010) reported that chemical composition of frankfurter as; Moisture 63-73%, Protein 10.63-16.43%, Fat 1.71- 12.22%.

2.4.5: Physical Properties:-

2.4.5.1: Cooking loss:

It is the ability of meat to hold its own or added water during cooking. The cooking loss % defined as the water lost during the

cooking meat expressed as % (Ahmed, 2012). The loss in sausage after cooking may be affected by several factors such as make sausage by incorrect recipe, Temperature at comminution, cooking system and cooking time, water holding capacity, moisture , fat retention and the type of ingredient used in their formulation (Nurul *et al*,2010, Essien2003). Percentage cooking loss should be established during product development using the cooking system that is agreeable to the customer, since such losses could vary tremendously with each system. (Celia Bennett, 2013). John and Barbut (2013) reported that cooking loss in Frankfurter as 3%. Akwetey *et al*., (2012) studied that cooking loss% in Frankfurter as 9.47. Regina *et al*., (2012) found the Cooking loss in Frankfurter 4.30%.

2.4.5.2: Water holding capacity:

Judge *et al.*, *(*1989) defined the water holding capacity as the ability of meat to retain its own or added water during the application of external forces such as cutting, grinding or processing. (WHC) of meat is one of the most important factors of meat quality both from the consumer and processor point of view. Muscle proteins are capable of holding many water molecules to their surface. As the muscle tissue develops acidity (decrease of pH) the water holding capacity decreases. Water bound to the muscle protein affects the eating and processing quality of the meat (Gunter and Peter 2007). Water is present in meat as bound water (4-5% of total water) and "free water". Hydrophilic groups attach bound water to protein, while "free water "is immobilized by the physical configuration of meat proteins. Changes only take place in "free water" and are manifested as weep, drip or shrink (aberle *et al.*,

2001).Adam and Abugroun (2010) found the WHC in frankfurter as (1.84). Maha . M (2009) stated WHC in frankfurter as (2.2).

2.4.5.3: PH:

The pH unit measures the degree of acidity or basicity of a so lution. PH the negative logarithm of the hydrogen ion concentration. Walker and Betts (2000) reported that, ultimate pH of meat was significant for resistance to spoilage because most bacteria grow optimally at about pH below pH 7 not below pH 4. The pH is an important determinant of microbial growth. Most of the microorganisms grow at a neutral pH of 7.0 (Romans et al., 2001; Kim, 2006). The quality factors affected by pH include: color, grading characteristics and shrink of carcasses and wholesale cuts, texture, cooking loss, tenderness of steaks, processing and binding characteristics of comminuted and restructured meats like sausages (aberle *et al.*, 2001). Gerardo *et al*., (2014) reported that the pH in frankfurter as 5.85. Regina et al (2012) found that the pH in frankfurter as 6.30, also Akwetey *et al*., (2012) reported that pH as 5.89.

2.5: Quality of sausage:-

Meat quality is defined as the total satisfaction that meat gives to the Consumer .Meat quality is a combination of physical structure and chemical characteristics of meat, which result in desirability, from the stand point of appearance and acceptability (Pearson, 1960 and Rana, 2008).

2.5.1: Color:

Color is an important criterion of raw or cooked meat and meat product. It reflects the proper composition of the product, in particularly relation of meat to other compounds, freshness of raw materials, texture taste and proper conditions of storage (Klak *et al.,* 2001; alberti *et al*., 2002). Color loss in sausage is caused partly by oxidation of meat pigment myoglobin to metmyoglobin (Wilson, 1981).

2.5.2: Flavor:

Meat flavor develops from the interactions of non-volatile precursor including free amino acids, during cooking, (mottram, 2002). Tow important points must be considered in meat flavor. The first is that each kind of meat has a characteristic flavor, and second is that the flavor can be modified by change in the condition of coking (example roasting or broiling) (Herrickson, 1978). Aberle *et al*. (2001) reported that, components of meat responsible for flavor have not been completely identified. It's likely that many constituents of muscle connective and adipose tissues become flavor compound upon being heated.

2.5.3: Texture:

Food texture has been defined as the composite food of those properties which arise from the structural element, and the manner in which its registers with the physiological sense (Szezeriak, 1963). Sensory perception of texture depend on the deformation resulting from the application o pressure and for surface properties such as toughness, smoothness or stickiness estimated by sense of touch, while consumer

develops some idea of texture by handling the meat, it is more effectively indicated by contact sensation in the mouth. The hard palate determiners most of the coarseness of food (Yeatman, 1972).

2.5.4: Juiciness:

The sensation of juiciness of cooked meat may be separated into two effects, the first is the impression of wetness during the first chews produced by the rapid repid release of meat fluids, the second is one of sustained Juiciness apparently because of the slow release of serum and stimulating effect of fat on salivary flow (Tibin,1978). Juiciness is closely related, the more tender meat the more juiciness varies inversely with cooking losses (Judg *et al*,. 1990).

2.6: Quality control in sausage making:

Control of the quality of sausages manufactured is essential to the success of making business. Quality control in sausage production is not a simple operation or the last operation in the production line.

1. Quality control in a sausage factory includes the control of all raw materials used in sausage manufacturing.

2. The control of all-important points in the steps of sausage making operation.

3. Quality control of finished products.

2.7: Quality characteristics of sausages:

The essential features for sausage are Color, flavor, texture, appearance, keeping quality. Color in general sausages; whatever their formulation

and composition should have a uniform basically red color. To obtain the desirable color of finished sausage, it's necessary to add an optimum amount of nitrite or nitrate. Good color in sausage can be destroyed by improper storage or by prolonged contact with air (Isidor et al., 1972).

Flavor: Sausage should have a pleasing flavor, typical for each product .The flavor of sausage depends upon meat, spice blend and method of processing (Isidor *et al.*, 1972) Fresh sausage and some of the smoked and cooked sausages show their optimum flavor characteristics when heated, while sausage eaten cold should be already fully flavored at room temperature (Isidor *et al.*, 1972).

Texture: The texture of sausage depends upon the selection of meats, proper chopping and curing, and through smoking and cooking (Isidor *et al.*, 1972).

General appearance: Each piece of sausage in high quality batch must be uniform in size (length and diameter), shape and in other properties important for general appearance (Isidor *et al.*, 1972). All sausages must be always uniformly smoked, free from wrinkles or prominent, surface jelly deposits, streaks or block and smoked spot and discoloration on the surface or when cut (Isidor *et al.*, 1972).

Keeping quality: Sausages are perishable products, the keeping qualities of which are not only dependent upon their types, but also upon the sanitary level of production (Isidor *et al.*, 1972).

2.8: Microbial contamination:

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*., 1990) .Frankfurters are cooked and smoked sausages. They are produced from fresh meat that is cured during processing, fully cooked, and smoked. A number of product characteristics influence the growth of microorganisms. Microbial hazards are a major concern in the production of foods of animal origin. Studies related to microbial contamination have concentrated on carcass; however, meat and meat products can be contaminated with bacteria during manufacturing and packaging. Micro- organisms gaining access into sausage from meat, spices, and other ingredients, from environment, equipment, and handlers during processing affect the microbiological status of the products (Sachindra.N *et al* ., 2015). The safety of food of animal origin for human consumption has become an essential part of the public health debate. Several meat-processing plants have begun to utilize a program called the Hazard Analysis and Critical Control Point (HACCP) system to reduce pathogenic contamination. This program identifies the steps in the conversion of livestock to human food where the product is at risk of contamination by micro- organisms (Ebru and Nalan, 2008). It is essential to identify potential risks related to product and microbial contamination sources for implementation of HACCP program in a sausage processing plant. (Ebru and Nalan, 2008).

Chapter three:

3.0 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 for determination of the chemical composition, some physical properties, sensory evaluation and assessment of bacterial contamination in the period October- November 2015.

3.1: Collection of samples:

Nine samples of beef sausage Frankfurter (approximately 1kg) were collected at cities of Khartoum State (Khartoum, Bahri and Omdurman), one sample from each factory a day three respectively after processing and packing. The samples were pressured in container at temperature 4^{o}c transported to for determinate of chemical composition and the physical characteristics, and attributes of quality and sensory evaluation and Total bacterial count.

3.2: Proximate Chemical composition:

Determination of moisture, crude protein, fat (ether extract) and ash of the beef sausage (Frankfurter) samples were performed according to Association of official Analytical Chemist (A.O.A.C., 2002).

3.2.1: Moisture determination:-

Five grams from each sample were put in an oven at 100°c for overnight, and then the samples were taken out the oven, cooled in desiccators. The loss of weight was considered as the moisture content.

The moisture percentage was calculated as follows:-

Moisture%=

$$\frac{\text{Weight of the sample before drying} - \text{weight of dried sample}}{\text{Weight of the sample before drying}} \times 100$$

3.2.2: Crude protein determination:

Kjeldahl method was used to determine nitrogen percentage .Crude protein was determined by multiplying the amount of nitrogen times 6.25. One gram of each sample was digested in Kjeldahl flask by adding 10 gm of catalysts (mercury) and 25ml conc. Sulfuric acid ($H_2SO_{4)}$ .The mixture was heated for3 hours. The digested samples were cooled and then 100ml of distilled water was added to each flask .50ml 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 cured nitrogen was as follows:-

$$\text{Nitrogen content\%} = \frac{TV \times N \times 14}{1000 \times \text{wt.of sample}} \times 100$$

Where:

TV: Actual volume of HCl used for titration.

N: Normality of HCl.

14: Each ml of HCl is equivalent to 14 mg nitrogen.

1000: To convert from mg to g.

Crude protein %: Nitrogen %×6.25

3.2.3: Fat determination:-

Fat was determined by the ether extraction .Two grams from the minced samples were taken into Soxhlet apparatus. The sample was subjected to continuous extraction with ether for 6hrs. The samples were then removed from the extractor and allowed to dry for 4hrs at 80ºc in drying oven till no traces of ether remained. The sample was cooled and weighted for ether extraction percentage. The calculation was as following:-

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

3.2.4: 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 3hrs, and then the crucible was taken out, cooled into desiccators and weighed. The ash percentage was calculated by the following formula:

$$\text{Ash\%} = \frac{\text{wt. of ash}}{\text{Wt. of sample}} \times 100$$

3.3: Physical properties:

3.3.1: Cooking loss %:

Cooking loss percentage was determined according to (Honikel, 1998) method, by weighing differences in sausage samples before and after cooking. Individual samples are placed in thin walled polyethylene bags in the oven at 100 ºC for 10 minutes, then it was removed from the water bath and cooled in running tap water. Then, sausage samples were taken from the bags, mopped dry and weighed. The cooking loss percentage was expressed as the following equation:

$$\frac{\text{Weight of the sample before cooking} - \text{weight of the sample after cooking}}{\text{Weight of the sample before cooking}} X100$$

3.3.2: Water holding capacity (WHC):-

About one gm from each sample was used for WHC determination. Each sample was placed on humidified filter paper and pressed between two Plexiglas plates for 1 minute at 25kg/cm² load. The meat filter area was traced with a ball pen and the filter paper was allowed to dry. Meat and moisture areas covered by meat (meat film area) was subtracted from the moisture area and then divided by meat film area to give the ratio expressed as water

holding capacity of the meat. A large ratio indicates an increase in the watery condition of the flesh or a decreased in the water holding capacity (Babiker and Lawrie, 1983).

Water Holding Capacity =

$$\frac{\text{Loose water area} - \text{Meat film area}}{\text{Meat film area}}$$

3.3.3: PH:-

10 gm of each sample was blended with 100ml distilled water in a blender jar at high speed for one minute pH measurement was done in the laboratory by pH meter (Okerman, 1981).

3.4: Sensory Evaluation:

Sensory evaluation was conducted in the meat laboratory. Samples were offered to 10 semi-trained sensory panelists who evaluated color, texture, juiciness, flavor, and overall acceptability using an 8-point (hedonic scale) card (Cross *et al*., 1978), in which the highest score of 8 being extremely desirable and score 1 being extremely undesirable.

3.4: Total Bacterial Count:

Standard plate count agar media was used to determine the total viable bacterial count. Samples were prepared according to the technique described by ICMSF (1987). One gram from each sample was transferred under aseptic condition to glayuss tube containing

nine 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, 5 fold serial dilutions were prepared up to 10-5. About 10-15 ml of plate count agar media poured aseptically into sterile Petri-dishes. One ml from the dilutions was added to each Petri– dish, and then they were incubated at 37˚c for 48 hours. A colony counter was used for counting colonies grown in the incubated Petri – dishes.

3.5: Statistical analysis:

Complete Randomized Design was used to analyze the results obtained from this study and subjected to One Way ANOVA followed by least significant difference test (LSD) using the SPSS 17.0 (2007) computer program.

Chapter four

4.0 Results and Discussion

4.1: Proximate Composition:

Chemical composition of Beef Frankfurter from different factories is shown in Table (1). There was significant difference among the samples collected from the three meat factories at Khartoum State the chemical composition components (moisture, protein, fat, ash).The moisture content of samples collected from Omdurman factory recorded the highest values (67.67%),followed by sample from Khartoum (66.50%) and Bahri (62.83%). Omdurman factory Beef Frankfurter had the highest moisture content compared to Khartoum factory and Bahri factory Beef Frankfurter. The result of Omdurman factory in this study is similar to Emel and Nalan (2014) who reported moisture % in Beef Frankfurter as (67.04%). The result of Bahri factory in this study is similar to Regina *et al*., (2012), who reported moisture % in Beef Frankfurter as (62.34%). This result agree with Sudanese Standards and Metrology Organization SSMO (2008) limits which reported that, the ice and water added should not exceeded 10% of the final products.

The crude protein of the samples collected from factory Bahri recorded the highest values (25.57%) followed by Khartoum factory (20.80%) and Omdurman factory (17.10%). Omdurman factory from Beef Frankfurter had the lowest protein content compared to Khartoum factory and Bahri factory Beef Frankfurter. The Factories results Omdurman factory agree to Emel and Nalan

(2014) who reported the crude protein in Beef Frankfurter as (17.1%).

The fat content of the samples collected from Omdurman factory reported the highest fat content (5.74%), while Khartoum factory (5.10%) and Bahri factory samples (4.85%). The result of this study was disagred with Gerardo (2014) and Regina (2012) who reported the fat content in Beef Frankfurter as (17.8%, 16.14%) respectively, which may be also to the difference in sample Formulation. This result was nearly to Emel and Nalan (2014) who reported the fat content in Beef Frankfurter as (5.88%). In Beef Frankfurter agree with SSMO (2008) who reported the Cooked Smoked Sausage content no more than 25% fat.

In respect to the ash content the study showed there were significant difference ($P \geq 0.05$) among the samples from the three factories, The sample collected from Omdurman factory was recorded the highest content (3.47%) followed by sample from Bahri factory (3.27%) and Khartoum sample factory (2.60%). Which were in the Omdurman factory results agreed with Emel and Nalan (2014) who reported the ash in beef frankfurter as (3.4%) Results of Khartoum factory were closer to Regina (2012) who reported the ash content was (2.93%).

Table (1): Proximate composition of Beef Frankfurter sausage in Khartoum State:

Parameter / Treatment	Moisture	Protein	Fat	Ash
A	62.83±1.26[b]	25.57±0.21[a]	4.85±0.26[b]	3.27±0.25[a]
B	66.50±2.18[a]	20.80±0.17[b]	5.10±0.10[b]	2.60±0.36[b]
C	67.67±1.61[a]	17.10±0.10[c]	5.74±0.15[a]	3.47±0.06[a]
Stander Error	0.986	0.217	0.112	0.150
Sign.	*	**	*	*

[a,b] mean in the same column with by different superscript are at significantly different (P<0.05). =Means in the same row bearing different superscript letter are significantly different

* Significantly different at (P<0.05).

** Highly significantly different at (P<0.01)

A Bahri Factory

B Khartoum Factory

C Omdurman Factory

4.2: Physical Analysis:

There was a significant difference between samples collected from Khartoum State Factories in the water holding capacity (WHC). There was no significant difference in the cooking loss% and PH.

Water holding capacity in Table (2) showed that, Frankfurter samples from Omdurman Factory recorded the highest WHC value (2.22) compared to samples from Khartoum factory and Bahri factory (2.06, 1.88) respectively. These results of Bahri factory agree with Adam and Abugroun (2010) who found the water holding capacity as (1.84). The result of Omdurman factory in this study is similar to Maha (2009) who reported water holding capacity in Beef Frankfurter as (2.2).

As for Cooking loss% there was no significant difference among the samples from the three factories (Khartoum, Omdurman, and Bahri), although the sample taken from Khartoum meat factory showed decrease in cooking loss (8.65%) which agrees with Akwetey *et al*., (2012) who reported the cooking loss in beef Frankfurter as (9.47%), and disagrees with John and Barbut (2013) and Regina *et al*., (2012) who reported the cooking loss% of Frankfurter beef sausage was (3% , 4.30%) respectively.

PH in Table (2) showed that, there was no significant difference in pH values among the samples from Omdurman factory as (5.97), Khartoum factory (5.92) and Bahri factory (6.04). The result of

samples from Bahri meat factory was agrees with Regina *et al.,* (2012) who reported the pH value in beef Frankfurter as (6.3) also the results of Factories Khartoum, Omdurman agree with Gerardo et al (2014) and Akwetey *et al*., (2012) who reported the pH in Beef Frankfurter as (5.85 , 5.89) respectively.

Table (2): Physical characteristics of Beef Frankfurter sausage in Khartoum State:

Parameter / Treatment	Cooking loss%	WHC	PH
A	9.24±0.89	1.88±0.02[b]	6.04±0.10
B	8.65±1.13	2.06±0.09[b]	5.92±0.05
C	9.72±0.43	2.22±0.12[a]	5.97±0.09
Stander Error	0.295	0.055	0.029
Significant Deference	NS	**	NS

[a,b] mean in the column Followed by different superscripts are at significantly different at ($P<0.05$).

NS mean no significantly different

** Highly significantly different at ($P<0.01$).

A Bahri Factory

B Khartoum Factory

C Omdurman Factory

4.3: Sensory Evaluation:

Sensory evaluation in Table (3) shows significant difference ($p \leq 0.05$) for sensory parameters color and juiciness, while the samples from Khartoum factory revealed the highest score compared to the two samples from factories in Beef Frankfurter, on the other hand the textures and flavors were not significantly differente among the samples. The results of the study was agrees in color with (Manal, 2007) who reported of Beef Frankfurter as (4.70, 4.50, and 4.10) but disagrees in texture (8.20, 6.60, and 7.40), Flavor (7.60, 7.60, and 7.40), and Juiciness (7.70, 5.20, and 6.60).

4.4: Total Bacterial Count:

As shown in Table (4) there was no significant difference in the total bacterial count (TBC) however, (TBC) of Beef Frankfurter from Bahri factory was similar to the Beef Frankfurter from Khartoum factory as (3.39 $\log10^4$ cfu/g). While, Beef Frankfurter from Omdurman factory reported (3.37$\log10^4$cfu/g) the result was proximate with (Ebru and Nalan.2008) who reported as (3.93 $\log10^4$ cfu/g).in their studys determination of microbial contamination in Frankfurter. Also the result agrees with Sudanese Standards and Metrology Organization (SSMO, 2010) limits which stated that, the total bacterial count not should exceeded 3.47×10^4 cfu/g).

Table (3): The sensory evaluation of Beef Frankfurter sausage in Khartoum state:

Parameter / Treatment	Color	Texture	Flavor	Juiciness
A	4.10±1.24[b]	4.20±0.96	4.13±1.54	4.03±1.22[b]
B	4.97±1.03[a]	4.73±0.98	4.63±1.25	4.80±0.96[a]
C	4.57±1.41[a]	4.67±1.32	4.37±1.25	4.77±1.14[a]
Stander Error	0.134	0.117	0.143	0.122
Sign.	*	NS	NS	*

[a,b] mean in the columns with different superscript are significantly different at ($P<0.05$).

NS means not significantly different.

* Significantly different at ($P<0.05$).

A Bahri Factory

B Khartoum Factory

C Omdurman Factory

Table (4): Total bacterial count of Beef Frankfurter in Khartoum state:

Treatment / rameter	A	B	C	Sig.
Total count micro	3.39 ± 0.24	3.39 ± 0.17	3.37 ± 0.07	NS

NS mean no significantly different

A Bahri Factory

B Khartoum Factory

C Omdurman Factory

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.1: CONCLUSION:

- All samples of beef Frankfurter were in conformance with SSMO Standard in chemical composition.
- Production of such low cost products will meet the growing needs of the increasing number of meat consumers for fast food products and at affordable prices.
- Despite the capabilities and potential of Sudan's agricultural and animal, the animal production industry is still traditional need for resettlement of technology in all its stages.
- The factories doesn't work by all operating capacity that it have and the power of one of them 25_ 30 t/ day on two shifts .currently energy 5.2 _ 5.3 t/ day.
- Lower purchasing strengths locally from prices height of meat, reflected on the prices products.

6.2: RECOMMENDATION:

- Further studies should continue in this field to produce meat and meat products that match with SSMO Standards.
- Sampling at the end of production and increasing the number of samples.
- Study on others types of frankfurter.
- Supervision monitory to the company and observing it to stand on setting quality.
- The development on domain mobilization "keeping and storing.
- Enlarging marketing outlets.
- Putting the plans "studies researches that objective to develop meat industry.
- Application of modern technologies in the production and industrialization meat.
- System quality application at collect industrializing stages and after comes out from the factories.

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Sensory Evaluation Form:

Evaluate these samples for color, texture, flavor and juiciness. For each sample, use the appropriate scale to show your attitude dy checking at the point that best describes your feeling about the sample, fi you any questions please ask. thanks for your cooperation.

Name: .... **Date:** ....

Sample code	Color	Texture	Flavor	Juiciness	Comment
( )					
( )					
( )					

By:

Color	**Texture**	**Flavor**	**Juiciness**
8/ Extremely desirable. 7/ Very desirable. 6/ Moderately desirable. 5/ Slightly desirable. 4/ Slightly undesirable. 3/ Moderately undesirable. 2/ Very undesirable. 1/ Extremely undesirable.	8/ Extremely desirable. 7/ Very desirable. 6/ Moderately desirable. 5/ Slightly desirable. 4/ Slightly undesirable. 3/ Moderately undesirable. 2/ Very undesirable. 1/ Extremely undesirable.	8/ Extremely desirable. 7/ Very desirable. 6/ Moderately desirable. 5/ Slightly desirable. 4/ Slightly undesirable. 3/ Moderately undesirable. 2/ Very undesirable. 1/ Extremely undesirable.	8/ Extremely desirable. 7/ Very desirable. 6/ Moderately desirable. 5/ Slightly desirable. 4/ Slightly undesirable. 3/ Moderately undesirable. 2/ Very undesirable. 1/ Extremely undesirable.