بسم الله الرحمن الرحيم

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College of Graduate Studies

Effect of Supplementing Different Levels of Gum Arabic on the Quality Characteristics of Beef Sausage

أثر إضافة مستويات مختلفة من الصمغ العربي على جودة خصائص السجوك البقري

A Thesis Submitted in Fulfillment for the Requirements of the Degree of Master In Animal Production in Tropics

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قوله تعالى: {وَمَا أُوتِيتُم مِّنَ الْعِلْمِ إِلاَّ قَلِيلاً}

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صدق الله العظيم

DEDICATION

To the Soul of my father and my mother, to my husband and lovely children Nour, Elaf, Mohamed and Yousif, to my friends , my dear Sara Mohamed (University of sudan) and Rasha Awad Abuagla (Pasgianos Company) and my brother Osman (Civil aviation) .

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الملخص

إجريت الدراسة لتقييم أثر اضافة إستخدام الصمغ العربي على جودة السجوك البقري. ثلاثة مستويات مختلفة من الصمغ العربي (صفر% ضابطة ، 1% و2%) اضيفت لتصنيع سجوك اللحم البقري . ستة كيلوجرام من اللحم قسمت الى ثلاثة مجموعات بثلاثة تكرارات . تم تحديد المحتوى الكيميائي ، الاس الهادروجيني , قوة الحفظ المائي , فاقد الطهي ، العد البكتيري والتقييم الحسي للعينات المصنعة ، أوضحت النتائج ان للتحليل الكيميائي زيادة معنوية ($p<0.05$) في محتوي الرطوبة ، الدهن و الرماد (61.1,00) الى (63.1,00) ، (3.07±.12) الى (3.30±.10) و(1.33±.06) الى (1.5±.10) على التوالى بمستوى معنوي ($P<0.05$) ، بينما نقص البروتين معنويا من (18.50±1.0) الى (18.1±.15) . اظهرت نتائج التحليل الفيزيائي فروقات معنوية ($p<0.05$)) في كل من الاس الهادروجيني ، قوة الحفظ المائي وفاقد الطهي وقد وجد نقصان في محتوى الاس الهادروجيني وفاقد الطهي (5.5±.07) الى (5.4 ±.07) و (63.00±1.00) الي (62 .00±1.00) على التوالي ، و زيادة الحفظ المائى (21.00±1.0) الى (23.00±1.0) . تاثر التقييم الحسي في كل من اللون كما تم تقييمه بواسطة المتذوقون بعدم وجود فروقات معنوية ($p>0.05$) خلال المعاملات بزيادة الصمغ العربي حيث ان مستوى صفر % من الصمغ العربي اظهر افضل درجة (2.5±1.34) بينما اظهر المستوى (2%) من الصمع العربي اقل درجة (2.00±.82) . بالنسبة للقوام فقد أظهر المستوى صفر% من الصمغ العربي افضل درجة (3.00±5.797) بينما أظهر المستوى (2%) من الصمغ العربي اقل درجة (2.25±1.43). بالنسبة لقوام فقد اظهر زيادة معنوية ($p>0.01$)، المستوى صفر% من الصمغ العربي افضل درجة (3.00±5.797) بينما اظهر المستوى (2%) من الصمغ العربي اقل درجة (2.25±1.43) ولكن النكهة فقد

اظهرت زيادة معنوية ($p<0.01$) مستوى صفر% من الصمغ العربي افضل درجة (1.53±.716) بينما اظهر مستوى (1%) اقل درجة (2.23±.1.18) ، بالنسبة للعصيرية فقد اظهر مستوى (صفر%) من الصمغ العربي افضل درجة ((2.5±1.8) بينما اظهر مستوى (1%) اقل درجة (1.5± .72) بزيادة معنوية ($p<0.05$) . ومن ناحية اخرى اظهرت نتائج العد البكتيري نقصان التعداد الحيوي للبكتيريا في مستوى (0 % and 2%) من (9.7±1.2) , (5.5± .7) على التوالي ، من النتائج افضل مستوى من الصمغ العربي يمكن اضافته للسجوك هو (2%) حيث كان مقبولا لدى المستهلك ، كما ان السجوك البقري المصنع باضافة الصمغ العربي بنسب مختلفة يودي لزيادة فترة صلاحية وجودة السجوك.

ABSTRACT

The study was conducted to evaluate the effect of utilizations of Gum Arabic on the quality of beef sausage .Three different levels (0% control, 1% and 2%) of Gum Arabic were used in the processing of beef sausages . Six kilograms of beef were divided into three groups with 3replicates. Chemical analysis was conducted , pH , Water Holding Capacity (WHC) Cooking Loss, total bacterial counts and sensory evaluation were determined .The result showed that chemical analysis had significant increase ($p<0.05$) in moisture content , fat and ash (61.00±1.00) to (63.00±1.00), (3,07±.12) to (3,30±.10), (1,33±.06) to (1.50±.10) respectively at ($p<0.05$) , while the protein content significantly decreased ($p<0.05$) in the protein content (18.50±.10) to (18.1±.15) . Physical analysis had significant decrease ($p<0.05$) in pH and cooking loss content (5.5±.07) to (5.4±.07), (63.00±1.00) to (62.00±1.00) respectively at ($p<0.05$), while water holding capacity increased from (21.00±1.0) to (23.00±1.0). Sensory evaluation was significantly affected , The color as evaluated by panelists showed no significant difference ($p>0.05$) among the treatments, the increase of Gum Arabic levels, as 0% level showed the best color score (2.5±1.3), while 2 % level showed the least score (2.00±.82). The texture showed significant increase at ($p<0.01$), as 0% level showed the best texture score (3.00±1.6), while 2% level showed the least score (2.00±.73), however the flavor showed significant increase at ($p<0.01$) , 0% level showed the best flavor score (2.5± 1.18), while 2% level showed the least score (2.2±.95) and the juiciness showed significant increase at ($p<0.05$), 0% level showed the best score (2.7±1.9) , while 2% level showed the least score (2.00±1.3) . On the other hand Gum Arabic leads to significant decrease in total viable bacterial count, at levels (0%, 2%) were (9.7 ± 1.2, 5.5 ± .7) respectively. From the results the most desired level of Gum Arabic to be added to sausage recipe is 2% which is acceptable to the consumer, and there was increase the shelf life and quality of processed beef sausage added with Gum Arabic.

LIST OF CONTENTS

List of tables

CHAPTER ONE

INTRODUCTION

Sudan has a large amount of animal resources which has match it to compete in meat industry there are approximately 102.235.000 heads of cattle, sheep, goat and camel (MARFR, 2012).

The meat industry products is a big type of meat products ranging from all muscle to ground and comminuted products , each of which order the equipment of meat processing is different to show the principles of operating modern which has develop over the centuries to help processors and butchers perform different tasks (e,g.cut, inject brine , stuff, cook, slice) most operate under fairly similar principles totally,equipment was designed for individual ,single tasks (e.g., mixing) but to day many processing lines are designed to accommodate continuous, operations (Shai Barbut; 2015) .

Generally foods are processed commercially for one of the following: (1) extend the shelf life of the processed food form, (2) alter the characteristics of the product, (3) separate components from the complex mixture of bio – chemicals (Maha., et al 2014).

Sudan has been still single largest producer of gum Arabic, the country supplies about 75% of the world needs of gum Arabic, (Gabb, 1997, Karamalla, et al, 1998).

Gum Arabic is added to any meats that have been processed or have ingredients such as flavorings added to them likely to contain Gum Arabic. This includes hot dogs, sausages, luncheon meats and canned fish. (Eqbal and Aminah /2013).

The Objectives of this study are:-

- The use of Gum Arabic as binder and extender in sausage.

- To increase Nutritional value of sausage and development the making sausage.
- Gum to increase the shelf life and preservation of the sausage.

Chapter tow

Literature Review

2. 1 Meat:

Meat is one of the most important foods in the diet for the vast majority of people (Delgado, 2003). It supplies easily absorbed iron is a concentrated source of high quality protein and some of the B- vitamins and its essential amino acids content usually compensate for deficiencies in diets made up mainly of cereals and other vegetable proteins (Sulieman et al., 2012) and small proportion of carbohydrate (Shai Barbut, 2015). It is famous very nutritious food as an excellent source of high quality protein. Meat consumption in developing countries continuously increasing from modern annual per capita consumption of 10kg in the 1960 to 26 kg in 2000 and reached 37 kg at the year 2030 (Gunter Hautzinger ., et al 2007) .

The type of meat is Beef, Veal, mutton, Pork, Milk, Camel and Goat Meat (Radomir Lastity 1985).

2.2 Chemical composition of meat:

Meat is 73% water, 22% protein, 4% fat, 1% Ash (Rendle and Keeley, 1998).

2.2.1Water:

Water is quantitatively the most important component of meat comprising up to 75% of weight (Varnam and Sutherland, 1995) and has an important influence on color, texture and surface appearance (Toldra, 2006).

Most of water in muscle is present in the myofibrils, in the spaces between the thick filaments of myosin and the thin of actin / tropomyosin (Lawrie and Ledward, 2006).

2.2.2 Protein

Protein is the most valuable component in meat from the nutritional and processing point of view (Heinz and Hautzinger, 2007). It is the building block of the muscular tissue (Rendle and Keeley, 1998) and it is used to

produce hormones, enzymes and hemoglobin. (Hoffman and falvo, 2004). Protein is a complex molecule made up of simple organic molecules known as amino acids (Khan and Saxena, 2006). Protein has different amino acid composition (the type and number of each amino acid present in the protein). Size, conformation and function (Khan and Saxena, 2006)

2.2.3 Fat and Fatty Acids:

The fat portion of meat includes some fat – soluble substances, including some vitamins (Rendle et al., 1998). The fat may be present as fat (between the muscles), intramuscular fat (marbling, i.e. within the muscles) and subcutaneous fat (under the skin or adipose tissue) (Scollan, 2003) muscle, fat, contributes importantly to various aspects of meat quality and is central to the nutritional value of meat (Wood et al., 2007).

Fat acts as one of precursors of flavour by combining with amino acids from proteins and other components when heated (Denh, 2006).

2. 3 Physical Properties of meat:

2.3.1 pH

The pH is an important determinant of microbial growth; high pH beef has high spoilage potential and ashort shelf – life reported that ultimate pH of meat was significant for its resistance to spoilage because most bacteria grow optionally at about pH and not blew pH 4 load increased with increase in pH of the meat product (Gunter Heinz et al., 2007).

2.3.2 Water Holding Capacity (WHC):

The water holding capacity of meat is one of 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. To obtain good yields during further processing including cooking, the water holding capacity needs to be at a high level (except for

uncooked fermented and / or dried products which need to lose water during processing).Water holding capacity varies greatly among the muscles of the body and among animal species. It was found that beef has the greatest capacity to retain water, followed by pork, with poultry having the least (Gunter Heinz et al., 2007).

2.3.3 Cooking Loss:

Cooking loss is one of the most important properties of sausage products as it is related to water holding capacity. There is variation in water holding capacity among different types of meat from different animal and muscles (Lawrie, 1991), Kannan et al., (2001). Higher holding capacity of meat products and is often unique characteristic of particular product ranging from coarse comminuted, to finely comminute to from an emulsion (FAO, 1991).

In ash percent was obtained on addition of GA which could be attributed to high mineral profile of gum (Mhinzi et al., 2008).

2.4 Nutritional value of meats:

2.4.1 Proteins:

The nutritional value of meat is essentially related to the content of high quality protein. High quality proteins are characterized by the content of essential amino acids which cannot be synthesized by our body but must be supplied through our food. In this respect the food prepared from meat has an advantage over those of plant origin. There are vegetable proteins having a fairly high biological value, for instance soy protein, the biological value of which is about 65% of that of meat (Gunter Heinz et al 2007).

2.4.2 Fats (Lipids of meat):

Animal fats are principally triglycerides. The major contribution of fat to the diet is energy or calories. The fat content in the animal carcass varies from 8 to about 20% (the latter only in pork). The fatty acid composition of the fatty tissues very different in different locations. External fat (body fat) is much softer than the internal fat surrounding organs due to a higher content of

unsaturated fat in the external parts .The high fat contains in some processed meat product (Shai Barbut., 2015) .

2.4.3 Minerals:

The minerals contents of meat shown as ash include calcium, phosphorus, sodium, potassium, chlorine, magnesium with the level of each of these minerals above 0. 1% and trace elements such as iron, copper, zinc and many others. Blood, liver, kidney, other red organs and to a lesser extent lean meat, in particular beef are good sources of iron, Iron intake is still widespread amongst children and pregnant women. Iron in meat has a higher bio-availability, better resorption and metabolism than iron in plant products (Gunter Heinz et al 2007).

2.4.4 Vitamins:

Meat and meat products are excellent sources of the B- complex vitamins generally meats contain an appreciable percentage of vitamin A, C ,D , E and K , Most of the vitamins in meat are relatively stable during cooking or processing, although substantial amounts may be lose in the drippings or broth . The drip exuding from the cut surface of frozen meat upon thawing also contains an appreciable portion of B-vitamins .This indicates the importance of conserving these fractions by making use of them in some way , for example through direct processing of the frozen meat without previous thawing (which is possible in modern meat processing equipment) . Thiamine (vitamin B1) and to a lesser extent vitamin B6 are heat –labile. These vitamins are partially destroyed during cooking and canning (Gunter Heinz et al 2007).

2.5 Meat Quality Attributes:

The characteristic quality of beef meats can be defined and clean many different ways. There are three main factors: safety, nutritional, and palatability (tenderness, juiciness and flavor of the beef).

Palatability: It is dependent on such factors as: color, aroma, flavor, juiciness and tenderness (Toldr´a, 2006).

2.5.1 Meat colour:

Colour is one of the most important factors, which influences on consumer choice regarding visual evaluation of raw meat, because it is the first factor seen by the consumer and is used as an indication of freshness and wholesomeness (Joo et al ., 2013).

Meat colour is on species, age, and muscle type, and the colour differences are due to the different content of myoglobin in muscle (Joo et al., 2013).

Myoglobin is the major pigment in meat (Rendle and Keeley, 1998). The greater the concentration of myoglobin, the darker is the colour of meat (Egan et al., 1988).

In different environments, myoglobin has different form, each with a slightly different colour. e. g in cured meat it is pink , in very fresh meat it is purplish- red , and in meat that has been exposed to the air it is bright red (Rendle and Keeley, 1998) .

Colour differences of myoglobin depend on its oxygen content, since myoglobin is the oxygen carring protein of muscle (Egan et al., 1988). In the absence of oxygen myoglobin is in the reduced from that is why it is purple, but in the presense of oxygen it forms oxymyoglobin which is bright red (Egan et al., 1988).

The myoglobin content in muscle is affected by factors such as exercise and diet of the animal as well as genetic and environmental factors (J00 et al ., 2013).

In red meats, abright red colour associated with ahigh content of oxymyoglobin is appositive determinant of quality, while brown metmyoglobin contein is anegative determinant (Varnam and Sutherland, 1995).

The appearance of the meat surface to the consumer depends , however, not only on the quantity of myoglobin present but also on the type of myoglobin molecule, on its chemical state and on the chemical and physical condition of other components of the meat (Lawrie and Ledward, 2006) .

The age of an animal at the time of slaughter has Avery definite effect on the colour of the meat. As aging time was increased, colour intensity or bloom also increased (the development of red colour was greater with longer aging) (Mancini, 2012).

As the animal progresses in age, the colour of the lean becomes darker (Marchello and Dryden, 1968).

In addition, colour may be influenced by drop in pH rate is more stable at relatively higher pH values (Toldra, 2006). Because it affects enzyme activity and the rate of oxygenation (Boles and Pegg, 2001). The higher the pH value, the darker the colour of meat (Lomiwes et al 2012).

By changing the enviroment is which meat is stored and packaged, the colour of the meat can be controlled (Rendle and Keeley, 1998). (Before the meat product reaches consumers, meat processors use colour to monitor processing and ensure the quality and freshness of the meat Colour measurement is also used to determine the amount of marbling akey quality component, in red meats) (Marchello et al, 1968; Varnam et al 1995).

2.5.2 Meat texture:

Meat texture is influenced not only by the quantity of collagen but also its solubility on heating (Vasanthi et al., 2007).

Concluded that there are significant changes occurring over time on the texture attributes evaluated when he used two meat products (salted pork loin and salted bacon) treated with two commercial liquid smoke flavourings (Martinez et al ., (2004a).

2.5.3 Meat flavour:

The taste of meat is different for different animal species. However, it may sometime be difficult to distinguish the species in certain food preparations. For instance, in some dishes pork and veal may taste similar and have the same chewing properties. Mutton and sometimes lamb has acharacteristic taste and smell, which originates from the fat, e.g. intera – and intermuscular fat, may imprint this typical smell and taste on the meat, particularly of meat from old animals. Feed may also influence the taste of meat (e.g. fish meat). In addition, the sex of the animal may also give a special taste and smell to the meat. The most striking example is the pronounced urine – like smell when cooking old boar's meat. Meat fit for human consumption but with slightly untypical smell and flavour, which may not be suitable for meat dishes, can still be used for certain processed meat products. However, it should preferably be blended with normal meat to minimize the typical desirable taste and odor of meat is to a great extend the result of the formation of lactic acid (resulting from glycogen breakdown in the muscle tissue) and organic compounds like amino acids and di- and tripe tides broken down from the meat proteins (Egan et al; 1988).

In particular the aged (matured) meat obtains its characteristic taste from the breakdown to such substances. The meaty taste can be further enhanced by adding monosodium glutamate (MSG) (0.05-0.1%) which can reinforce the meat taste of certain products. MSG is a frequently used ingredient in some meat dishes and processed meat products in particular in Asian countries (Gunter Heinz., et al 2007).

2.5.4 Meat juiciness:

Juiciness of meat is very important in regard to eating quality and is influenced by many factors including: ultimate pH, fat content, marination, cooking method and degree of doneness (Montogmery and Leheska, 2008)

and also by physiological and psychological factors inherent to individual tasters (Juarez et al ., 2012).

2.6 Factors affecting the nutritional value of meat:

The animal age, meat type, meat grinding, method of cooking, the making and the processed meat products (Gunter Heinz., et al 2007).

2.7 Meat microbiology:

The contamination of meat come from different sources including environment and equipments with which meat comes incontact during bleeding until consumption. Ray and Bhunia, (2008) and Pesavento, et al., (2010).

The spoilage of meat was defined as the state at which meat become unfit for human consumption (Judge et al., 1990).

2.8 Meat preservation:

Thermal processing, specifically retort processing, has been used as a common preservation technique in food industry for shelf stable low acid foods. Commercial retort processing ensures as The United States Code of federal Regulations defines commercial sterility as ' The condition achieved by application of heat, chemical sterilant (s), or other appropriate treatment that renders the equipment and containers free of viable microorganisms having public health significance, as well as microorganisms of non – health significance, capable of reproducing in the food under normal no refrigerated conditions of storage and distribution (USFDA , 2009).

Processed foods and food stuffs, which retain natural flavour, colour, texture, nutritional characteristics, and contain fewer additives (e.g preservatives) -especially chemical additives (Ohlsson and Bengtsson, 2002).

2.9 The sausage:

The word sausage originally comes from the latin word salsus which means salted or preserved in ancient time. People did not have refrigeration to

preserve their meat and so making sausage was a way of overcoming this problem (Google, 2004).

Good sausage makers are as discriminating about what goes into as winemakers are about selecting grapes. Early sausage makers found that a wide range of raw ingredients could be used . The primary ingredients of sausage were the parts of the animal carcasses that could not be used in other ways. Today many primal parts are used in the production of sausage: However, the less tender cuts, organ meats and even blood can be made delicious when ground, spiced and cased (Martin and Julie, 1998).

The contemporary role of sausage fits conveniently into our modern lifestyle as an elegant appetizer for entertaining as well as the main course in quick- and easy " meals. Furthermore, sausages are a relatively safe product to consume because of the added effects of salt, Ph, cure, drying and cooking to preserve the product and eliminate harmful bacteria (Poker, 2006).

2.9.1 Microbiology of Aspects:

Sausage is exposed to high temperature during the heating process: But this temperature is not enough to inactivate all of the microorganisms present. During the processing stages after cooking sausages are also decontaminated with spoilage bacteria. The excessive proliferation of present micro flora in the sausage content or on the surface during storage causes economic losses because of spoilage and deterioration, especially. Lactic acid bacteria are considered to be a major component of the microbial population found on vacuum – packaged sausages (Ozdermir, 1997).

2.9.2 Sausage Quality Attributes:

Lactic acid bacterial growth on the surface of the sausages produces undesirable sensory attributes. Various methods have been used to prevent the growth of lactic acid bacteria and other spoilage microorganisms and to extend the shelf – life of vacuum – packaged sausages (Korkeala and Bjorkroth, 1997).

2.9.3 Sausage processing:

2.9.3.1 Meat:

Sausage making is agreat way to use less tender, low – value cuts and trim pieces. Good sausage begins with good meat Beef, veal pork , lamb , mutton and poultry are all suitable for use in sausage Amajority of sausage products are prepared with pork and beef . Often game meats can be used to make sausage. If you slaughter your own animals, meat from the heat, trimmings, and the thin cuts can be saved for sausage. Meat from the neck and back of poultry and meat from the entire carcass of spent fowl can also be used (Martin et al 2012).

2.9.3.2 Salt:

Salt is essential ingredient for flavor and functionality in sausage. It aids in the water binding and emulsifying capacity of meat proteins. Use of salt alone provides adry salty product. Which gives the sausage abitter taste of salt and an unattractive color. Salt should be pure and sufficiently finely granulated so it can dissolve easily in the water Salt is necessary for enhancing flavor, preserving the sausage from microbial spoilage, and extracting the soluble meat proteins. The extracted meat protein forms a film and coagulates during heating and binds the meat particles together providing a firmer texture for sausage (Martin et al 2012).

2.9.3.3 Casings:

Casings sausage may be formed in to loaves and oven baked, however, most sausages are either wrapped or packaged in bulk chub packs or stuffed into casings (Shai. Barbut, 2015).

Is used to make most sausage and other processed meat they determine sausage sizes and shapes. Two types of sausage casings are natural (animal casing) these casing are made from sheep, hog and cattle intestines, and synthetic (Regenerated collagen casing, cellulosic casing or fibrous casing (Shai But., 2015).

2.9.3.4 Non meat ingredients (additives):

2.9.3.4.1 Water (Chilled Water):

Is added to most sausage formulations to rehydrate the nonfat dry milk and to replace the expected moisture loss during smoking and cooking. Approximately 10 percent added water typically is used in moist types of cooked sausage A small amount of water (usually less than 3 percent) is added to fresh sausage to aid in stuffing, mixing,and processing . No wateris added to sausages that will be dried, such as summer sausage or pepperoni (Shi.Barbut, 2015).

2.9.3.4.2 Binders and extenders:

Sausage may contain other ingredients such as binders and or extenders to retain natural juices and reduce the cost of the formulation .Theseingredients may improve the binding characteristics, flavor, cook yield, slicing characteristics. There is awide variety of non meat products that meat processors can incorporable into sausage within the guidelines under USDA meat inspection regulations (Kramlich., et al 1973).

2.9.3.4.3 Seasonings:-

Used to flavour and colour foods as well add some antimicrobial / antioxidant properties.

Examples of spices derived from different plant materials are some listed below:

- Nutmeg
- Pepper
- Cinnamon
- Mace
- Coriander
- Ginger

Spices can be added in different forms depending on the product (dry, before being dried). Spices carry a high number of microorganisms .Therefore; they

should be thoroughly cleaned and pasteurized or sterilized. Heat treatment is an option, but is typically not the best approach because it releases many of volatile compounds (Shai Barbut. 2015).

2.9.4 Sausages classification:

Sausages can be classified according to degree of combinations to coarsely and emulsified sausages (Dytte et al ., 1981) . As stated by (Boyle, 1994) , there are five basic classifications of sausage there are fresh sausage , uncooked smoked sausage, cooked smoked , cooked sausage, dry and semi-dry sausages (Dytte et al., 1981).

2.9.5 Types of sausages:

Sausages are made from beef, veal, pork, lamb, poul, - try and wild game, or from any combination of these meats. Sausage industries has Be highly – mechanized method. Traditionally .aunique blend of Grey methods and fresh scientific, sausage was formed into Equal shapes, but it now the consumers need the shapes and sizes (Martin and Julie, 1998).

2.9.6 Sausage Making Equipment:

2.9.6.1Grinder:

Electric meat grinders are readily available in kitchen or restaurant supply stores or online. Based on your needs, also get the appropriate grinding plates and knives, ' meat stompers' (to push chunks of meat into the grinding gear) (Shai Barbut; 2015).

2.9.6.2 Bowl Chopper:

Bowl chopper cuts meat with high- speed rotating blades and a bowl that also rotates. It is used to produce finely ground, emulsified batter for sausages like hotdogs (Shai. Barbut, 2015).

2.9.6.3 Stuffer:

An electric piston sausage stuffer will fill casings much more quickly than a hand – operated, screw – type, and with fewer air pockets. A stuffer is not essential to making sausage at home; you can form the meat into patties or

wrap as bulk packages links in casings can be tied off with heavy string or by twisting the sausage at certain intervals (Martin et al 2012).

2.9.7 Sausage Making Procedures:

Sausage making is a continuous sequence of events. Each step in the proper sequence is important to a successful operation it is practical to consider each step separately or to assign more importance to one phase or operation , but for convenience and illustration, we can break sausage production down in to four basic processes (Martin et al 2012).

All sausages into a specific class are difficult because sausages are produced by many different method s. The successful push sausage making to need each step in the top sequence is necessary. It is not practical to look each step separately or to assign importance phase but for suitability, we can stopping sausage making into four steps: Selecting ingredients, grinding and mixing, stuffing and thermal processing (Martin et al 2012).

2.9.7.1 Selecting Ingredients:

Weighing or measuring the meat and spice ingredients is one of the most necessary steps in the concoction of perfect sausage .the meat most be fresh, high quality, clean, not contaminated with bacteria or other microorganisms, have the top lean- to – fat percent and have good binding quality . When we used meat for sausage making most be as safe and make it in your kitchen, lkselecting spices and seasonings and collecting them in high amounts is important. Cure, and major part of some form, is sodium nitrite (usually 6 ratios) on a salt base. it usually can be buy at a local box plant . Sodium nitrite is very important to stop production and growth of the fatal toxin produced by the microorganism Clostridium botulinum. It also gives the characteristic cured color to a sausage product and improves flavor . Trade products such as freeze Em pickle Tender quick and salt peter can be found in markets and pharmacy. If these are used, be sure to follow directions on the packages (Martin and Julie,. 1998).

2.9.7.2 Grinding and mixing:

For safety, keep the temperature of the meat as cold as possible during grinding and mixing. The usual procedure is to grind the various meats coarsely and then add the rest of the ingredients mixing thoroughly. Added water to dissolve the curing ingredients, to facilitate the mixing and to give the products their characteristic texture and taste. Mixing should be done before the final grind. Grinding improves the uniformity of the product by distributing the ingredients and making the particles the same size. So the cure and seasoning can be more evenly distributed. If you don't have a grinder, buy ground meat, add the seasonings and mix thoroughly by hand (Shai But 2015).

2.9.7.3 Stuffing:

The sausage emulsion, also known in the trade as mix, sausage dough, or batter, is transferred to stuffers for casings. At this point, the size and shape of the product is determined. There is type of stuffers: Piston, Pump, and One of the trades combines the feature of position and pump in single unit.

The piston – type stuffer is recommended for coarse ground sausage.

The impeller type pump is suitable of for emulsion type produce such as frankfurter. After the emulsion is stuffed into casing the encased mass is tied with thread or fastened with metal clips. In case of small sausage, such as frankfurter, stuffed casing are twisted or drawn together to produce links, ether by hand or mechanicall (Julie, 1998).

2.9.7.4 Thermal processing:

Sausage is smoked and heated in order to pasteurize it and extend its shelf life, as well as to impart a smoky flavor and improve its appearance. Smoking and heating also fixes the color and causes protein to move to the surface of the sausage so it will hold its shape when the casing is removed (Ehr et al 2007).

2.10 Definition of Gum Arabic:

Gum Arabic (Acacia Gum) is anatural agricultural as the Harsh; viscous exudates obtain from stems and branches of Acacia Senegal and Acacia Seneyal (Azeez, 2005, Badreldin 2008). of the Leguminous family under difficult conditions such as heat , dryness ,wounds and diseases (FAO, 1990).The type of Gum Arabic : Hashab (hard gum)from acacia Senegal ,Talh (friable gum) from acacia seyal (FAO, 1990).

2.11 Composition of GA:

Is effected most by the Location, tree age, season of exudation, storage type and the genetic factor. (Williams et al, 2000; Monternegro et al., 2012).

2.11.1 Chemical Composition of GA:

Are the following values:

Moisture (14.5%), ash (2.5%), protein (2.5%).nitrogen (0.34%), viscosity (15.2ml/g) and pH (4.34). The fat content and nitrogen free extract were 0.05% and 80.755%, respectively. (Kauther et al 2018). The increase in ash percent was obtained on addition of GA which could be attributed to high mineral profile of gum (Mhinzi et al., 2008).

2.11.2 Physical Composition of GA:

Are the following values:

The range value of water holding capacity reported for Acacia sinegal gum was 65.40-65.80 by Omer (2001).The cooking loss percentage recorded increase with increase in levels of GA, Which could be attributed to its water holding capacity (Munoz et al ., 2007)

2. 12 Physical characteristics of GA:

2.12.1 Water holding capacity (W.H.C):

Is the ability of the material to hold water against Acuteness (Hansen, 1978).

2.12.2 Solubility:

Gum Arabic is unique among the natural hydrocolloids because of its extremelyhigh solubility in water and can yield solutions of up to 60%

concentration and it is truly soluble in cold water, other gums are either insoluble in cold water or form colloidal suspensions 'not true solutions' (G.A.C, 1993). The hydrocolloids in food industry proved significant surface activity. Gum arabic is a natural polysaccharide (Chen et al 2006). Related the significance of protein components presenting in gum arabic to its emulsifying properties .it seems that the flexibility, solvent depletion (Philips et al., 1988) and improved water retention in salt soluble meat proteins (SSMP). (Chen et al. (2007)

2.12.3 Equivalent Weight and Uronic Acid:

Titrable acidity represents the acid equivalent weight of the gum, from which the uronic acid content could be determined (Karamalla, 1965, Anderson et al 1983).

Assessed the potentials of new parameters such as equivalent weight and total uronic acid content as additional qualifying indices. They found that the mean values for (Karamalla et al., 1998),

2.12.4 Viscosity:

(Most gum other than gum Arabic form highly viscous solutions at low concentrations of 1.5%). Gum Arabic unique in that it is extremely soluble in water and is not very viscous at high concentrations. High viscosities are not obtained with gum Arabic until concentrations of about 40-50% are obtained. This ability to form highly concentrated solutions is responsible for the excellent stabilizing and emulsifying properties of gum Arabic when incorporated with large amounts of insoluble maters (The viscosity of gum solutions will depend upon the type and variety used). At concentrations up to 40% gum Arabic exhibit typical Newtonian behavior. At about 40%. Solutions took up pseudo plastic characteristics as denoted by decrease in viscosity with increasing shearing stress (Sharma, 1979).

Studies of flow of gum solution play an important role in identification and characterization of their molecular structure. Viscosity could be presented in

many terms such as relative viscosity, specific viscosity, reduced viscosity and intrinsic viscosity (Kaufman and falcetta (1977).

2.12.5 Intrinsic Viscosity:

Karamalla,(1999) showed that wide variation in values for intrinsic viscosity and viscosity were obtained indicating that such parameters cannot be used as qualifying Indices.

2.12.6 Molecular weight:

Gum from Acacia Senegal was reported to have high molecular weight substances average 4×10 Mv.(Anderson et al ., 1983) The most common method used to determine the molecular weight was the intrinsic viscosity measurements(Anderson et al ., 1983 and Phillips and Williams., 1988) , which in appropriate solvent , produce high viscosity hydrocolloid suspension at low dry weight. Thus, hydrocolloids due to high binding and gelling property can be used as binder in meat (Annison et al., 1995).

2.12.7 Reducing sugars:

The presence of reducing sugars would give evidence to the reducing power (free reducing group) of the gum (Somoge, 1945). It is usually calculated as arabinose. Reported 0.16-0.44% as the range value of reducing sugar for Acacia Senegal gum Anderson and Karamalla (1966).

2.13 Functional Properties:

2.13.1Emulsifying Stability:

Gum Arabic is a very effective emulsifying agent because of its protective colloid functionality and has found wide use in the preparation of varied oil – in water food emulsions with most oils over a wide pH range and in the presence of electrolytes without the need for a secondary stabilizing agent. (Phillips and Williams., 1988).

2.13.2 Encapsulating agent:

Microencapsulating is a process where droplets of liquids, solids. or gases (core) are coated by thin film (coatings) e.g. gum Arabic. which protectsuntil it is needs (Joseleau and Ullmann 1990).

The coating on a core is semi- permeable and protects the core from severe conditions and controls substances flavoring in to the core. The major use for encapsulating in food industry is for liquid flavors. Encapsulating has been able to mask bitter tastes of compounds, reduce volatility and flammability of liquid, control release of materials, provide protection to compounds, and reduce toxicity, separate reactive materials and to make liquids behave like solid. Micro encapsulating by spray drying is the most economical and flexible way for the food ingredient to retain the needed properties in the final food product .this technique also has been used in pharmaceutical industries e.g., vitamins and minerals. Yet not widely used in the food industry (Joseleau and Ullmann (1990).

2.13.3 Gum Arabic microbiology:

Gum arabic has been subjected to extended research on its chemical, physical, and functional properties point at setting definite standard for quality control. However .little attention has been given to the microbiological aspects of these very important Goods. Studies about fifty – two formulations of Documented and Trade Acacia Senegal gum (raw and processing gum arabic) were tested for the count of total bacteria. Mould, yeasts and coli forms. The microbial loadings of raw gum one, and ranged between Nil to Top of < 10 cfu/ gm. Salmonella and yeasts were not detected in any of the formulations tested (Karamalla.,1999) .

A comparative microbiological study on Documented and Trade Acacia Senegal gum formulation obtained from various locations in the Sudan showed that gum Arabic considerable numbers of bacteria and fungi (Osman, 1998).

Sudanese Acacia Senegal gum confirmed the freeness of raw or processed gum Arabic from pathogenic bacteria (Khalid et al., 1988). Idris (1986) and Osman (1998) obtained similar conclusions.

The bacteria contaminating gum Arabic formulations were gram (+ve) rod shaped, spore- forming ones. Gram (-ve) non – spore forming rods and gram (+ve) cocci types of bacteria were also detected, but insignificant amounts. (Karamalla et al., 1998).

An experiment carried out to simulate the effect of sunlight and UV light on microbial load of formulation resulted in salient decrease in the bacteria and mould counts although the microbial counts were well within the acceptable limits, efforts have been made to develop a simple technique to reduce such counts (Karamalla et al., 1998**).**

2.14 Uses of Gum Arabic:

2.14.1 Main uses:

2.14.1.1 Food industry:

Gum arabic´s emulsifying and film forming properties, low viscosity, high solubility and stability in acidic media render it useful in many applications within the food and flavor industry. (Glicksman, 1979- Elizalde et al 1988).

The important functional properties of gum Arabic determine the rang of applications of such product into food , is related to interaction with water , its ability to hydrate , swell and solublize , in addition studies on water and oil absorption gum might explain its effectiveness in emulsion stability . (Elizalde et al., 1988).

In addition, gum Arabic is acceptable dietary intake; non – toxic, odorless, colorless, tasteless, so it does not affect the flavor, color or odor of the food to which it is added. In food products gum Arabic is used as a functional ingredient, which means that the typical function of gum Arabic, are emulsifier, flavoring stabilizer and retards sugar crystallization. (EEC,(1999).

The food applications of gum Arabic have been developed from its unequal combination of properties, emulsification, acid stability, low viscosity at high concentration; adhesive and binding properties and good mouth feel characteristics have been used in four main food area worlds wide in descending order of importance (Glicksmann, 1973).

2.14.2 Confectionary:

Gum Arabic is used to retard crystallization of sugar and to act as emulsifier and as stabilizer in frozen dairy products, such as ice cream and ices because of its water absorbing properties (Karamalla, 1999).

2.14.3 Beverages and emulsion:

Gum Arabic acts as oil and water emulsion stabilizer; it is a film forming agent preventing coalescence of the oil globules (Josehau 1990).

2.14.4 Flavor encapsulation:

Gum Arabic is an ideal carrier in flavor encapsulation because of its natural emulsifying and surface – active properties, good retention of volatile flavor (Glicksman 1979).

2.14.5 Bakery:

Gum Arabic is used in bakery due to its viscosity, adhesive and comparatively water absorption properties. Stabilizer and colloidal agent in beer and as film forming on oily surfaces in chocolate and snacks. Its low level of destabilization, high fiber content is useful in diabetic and dietetic products (Whistler and Bemiller., 1973).

2.14.6 Pharmaceutical industry:

Gum arabic is listed in British pharmacopoeia (1993), as an effective suspending acid and has been employed to suspend insoluble druges and to prevent the precipitation of heavy metals from solution through (the formation of colloidal suspensions (Whistler and Bemiller, 1973).

2.14.7 Medicines:

Human dietary intake studies have indicated a reduction in blood cholesterol levels when above average amounts of gum Arabic (25grams / day) are ingested in solution. The addition of a 7% gum arabic solution reduces the dissipation rate of the sodium chloride solution (Whistler and Bermiller, 1973).

CHAPTER THREE

MATERIALS AND METHODS

3.1 Location:

This study was conducted in the laboratory meat processing, in the Department of meat productin, faculty of Science and Technology of Animal Production (kuku). Sudan University of Science and Technology, during the period October 2018.

3.2 Samples collection:

The meat was obtained from mature beef animals purchased from Animal Production Research Centre (kuku) . Atotal of 6kgs of fresh beef . The samples were transported hygienically to the meat processing laboratory, in the Department of meat production ,Ffaculty of Science and technology of Animals Production (kuku) Sudan University of Science and Technology. Then the samples were kept in are frigerator at 4^{o}c for overnight.

3.3 Samples Preparation and Processing:

The meat trimmed and added the spices to the samples of three sausagese (table 1) to showed and added chilled water and skim milk 40g in sample A, chilled water and 10g gum arabic and 40g skim milk in sample B, chilled water and 20g gum arabic and 40g skim milk in sample C. The whole mixture was mixed well in a chopper and mixture was stuffed in sheep casings. Using piston stuffer, then linked, placed in polythene bags, labeled and frozen at -20^{o}C to wait the following tests.

(**Table 1):** Sausage Recipe:

Sample A (control)	Sample B (1% GA)	Sample C (2% GA)	Material
2kg	2kg	2kg	Beef meat
40g	40g	40g	Potato
20g	20g	20g	Bread crumb
36g	36g	36g	Salt
6g	6g	6g	Cinnamon
6g	6g	6g	Coriander
4g	4g	4g	Pepper cubed
4g	4g	4g	Black pepper
4g	4g	4g	nutmeg
40g	40g	40g	Skimmed milk
-	10g (1%)	20g (2%)	Gum Arabic
200ml	200ml	200ml	Chilled water

3.4 Chemical Analyses:

3.4.1 Determination of Moisture content:

The moisture content of each sample was determined by the method described by the AOAC (1995).

Tow grams of well mixed sample was weighted accurately in cleaned, dried Petri dishes using asensitive balance (Item No: AR214 OHAC, SCORO, USA). Then , the sample were place in an oven (Carblite Sheffield , desiccater and re- weighting after cooling to room temperatue, Again , the dishes were transferred to the oven and weighted after tow hours and this was repeated till aconstant weight was obtained . Then, the moisture content (M, C) as per –cent was calculated as the loss in weight:

$$\text{Moisture content} = \frac{(WS-WD)\ \%}{\text{Sample Weight (g)}}$$

Where:

Ws= Weight of sample before drying

WD= weight of sample after drying

3.4.2 Crude protein:

Crude Protein in the sample, was determined by micro – Kjeldahl method following the method of AOAC (1995).

Principle:

Sausage sample was digested with a concentrated acid so that the sample releasesits nitrogen content which can be determined by asuitable titration technique. A conversion factor of 6.25 (equivaient to 16g nitrogen) 100 grams of protein content. The Kjeldahl method in divided into three parts which can be summarized under the following:

A) Digestion

Sausage Sample (0.2 grams) was transferred into adigestion and then digested by heating for 2-3 hours in (3-5N) sulphuric acid. Digestion process was catalyzed by amixture 0.4of 10 parts K2S4 to one the part of CUS04.The heating was continued till the black colour turned to pale blue and the fumes disappeared which indicated that the digestion process was completed.

B) Distillation:

Sausage After the digestion has been completed the digestion flask was cooled and transferred to adistillation unit was then turned alkaline by addition of 20 ml of sadium hydroxide (40%) to release ammonia. Then, the released ammonia was distilled into 20 ml of 2% a boric acid in aconical flask with 2to3 drops of B romochresol Methyl red as indicator.

C) Titration:

The nitrogen content in the sample was then estimated by titration of the ammonium borate formed with astandard hydrochloric acid (.OIN). The titration continued till the colour of the solution turned to red (pink). Then, the fowlling formula was used to determine the protein concentration as per-sent

% Crude protein = (Tv N 14.OOXF) %

1000Xsample weight (g)

TV: actual volume of HCL usad for sample titration (Mihcl-ml blank).

N: normality of HCL.

F: Protein convertion factor

3.4.3 Fat content:

The sample fat content was determined by using a continuous extraction apparatus (Soxhlet type), as describe by Pearson, (1970)

The five gram (5+ or -1) samples were weight and transferred to an extraction thimble covered with a piece of glass wool and then placed in the soxhlet apparatus, After that, the soxhlet flask and the extraction process was continued for about six hours, Then, the fat sample was dried in an oven (Carblite, Sheffield, England) for 30 minutes to eliminate any remaining amounts of the solvent and the flask reweighted, the fat per-cent sauasge calculate by using the following equation:

Crude fat % = (W2- W1) 100%

Sample weight (g)

Where:

W1 = Weight of the empty soxhlet flask (g)

W2 = Weight of soxhlet flask with fat content

3.4.4 Determination of ash content:

The ash content of the sample was determined according to AOAC (2003) the empty crucibles were accurately weighted and then tow gram of sausage were transferred to each crucible by using a sensitive balance. Then , the crucible and their content were placed in a muffle furnace LEF-103S , watts : 2KW1OA serial no : 07033002 , Korea) at 550 TO 700 C for more than 6 hours until white to grey ash was obtained. After that, the crucibles were transferred from the furnace to a desiccator to cool room temperature and reweighted. The ash content was calculated by using the fallowing equation:

Ash content (%) = (Wt1- Wt2) 100%

Sample weight (g)

Where

Wt1= weight of crucible with the remaining a shed sample

Wt2 =weight of the empty crucible.

3.4.5 pH measurement:

The pH was determined for raw and processed meat samples of the various treatments. 10gms of the sample were placed in a blender jar, and 100 mls of distilled water were added, the mixture was blended at high speed for one minute. The pH of mixture measured using a pH- meter (Model l., Pusl Munchen 15).Which had calibrated with two standard buffers (7 and 4).

3.5 Physical Analysis:

3.5.1 Water Holding Capacity (WHC):

Approximately 0.5 gm of produce placed on a humidified filter paper and pressed between two plexiglass for 2 min at 25 kg/cm2 .Meat and moisture areas measured using a compensating planometer. The result expressed as ratio (R.Grau and G. Hamm, 1953). (1)The water holding capacity calculated from the equation:

Water Holding Capacity (WHC) = $\frac{\text{Loose water area} - \text{Meat film area}}{\text{Meat film area}}$

3.5.2 Cooking Loss:

Cooking Loss determined as Babiker (1990) by using thermostatically controlled water bath 90ºC for min, samples weighed before and after cooking .(4)

Cooking Loss = $\frac{\text{Weight before cooking} - \text{Weight after cooking}}{\text{Weight before cooking}}$

3.6 Sensory Evaluation:

The prepared sausage pieces were cooked on hot plate set at 180ºc for 30 minutes. Every piece was cut in to three parts and provided to the sensory

panelists to familiarize them with the properties. The panel consisted of twenty members from postgraduate students and staff of the faculty of animal production Science and Technology. Cooked beef Sausages were served to evaluate sensory attributes of color, texture, flavor, juiciness and over all acceptability. The panelists were asked to indicate to evaluate the processed sausages using 8 – point (hedonic scale) card (cross et al., 1978) in which the highest score of 8 being extremely desirable and Ibeing extremely undesirable.

3.7 Bacteriological Assessment of sausages:

Total viable bacterial counts of fresh and frozen sausage were done after variable periods of sausage (0,7,15 and 21days) .

3.7.1 Preparation of sample:

25 grams of sausage samples were weighed. The samples were then grinded with marturn in hand, then blended with 225ml normal saline and shake well by hand three Duplicate samples were taken Monica (1991).

3.7.2 Culture Media:

Plate count agar. The medium was in form of dehydrated power .It was composed of casein enzymic hydrolysate- yeast extract. Dextrose and agar. It was prepared by dissolving 1.8gm. of medium in 100ml of distilled water, then put it on water bath to dissolve the medium completely.Sterilize by autoclaving at 151bspressure (121º C) for 15 minutes

3.7.3 Total viable count:

The best method for viable count is called Miles and Misra. The Miles and Misra method (or surface viable count) is a technique used in Microbiology to determine the number of colony forming units in a bacterial suspension or homogenate . The technique was first described in 1938 by Miles. Misra and Irwin Miles and Misra.(1938).

3.7.4 Miles and Misra (Dilution Method):

Using sterile pipertte 10 ml of the culture was transferred to a test tube containing 9.0 ml sterile normal solution. The contents were mixed by another sterile pipette and 1.0 ml of the mixture was transferred to a second tube until the fifth tube thus decimal serial dilutions up to 10-5 were prepared. Using sterile pipettes 1.0 ml of the dilutions 10-5 was transferred into duplicate sterile petri dishes.

3.7.5 Plates preparation:

- Three plates are needed for each dilution series, for statistical reasons an average of at least 3 counts are needed.
- Plates are divided into equal sectors (divided in to 4 quarter) . The sectors are labeled with the dilutions.
- You bring blood agar media, divide it into 4quarters. Using 2blood agar. Dry them thoroughty.
- Use 1/50 ml dropper (Pasteur pipette) remove about 1ml from the highest dilution (last dilution).
- Drop one drop in one quarter.
- Using the same pipette remove 1ml of the previous dilution and go on each time from the previous dilution.
- Using a bent glass rod spread your drop starting by higher dilution.
- The plates are left upright on the bench to dry before inversion and incubation at 37ºC for 18-24 hours (or appropriate incubations considering the organism and agar used).
- Next day remove petri – dishes from incubatorations will give a confluent growth over the area of the drop, or a large number of small /merged colonies. Colonies are counted in the sector where the highest number of full- size discrete colonies can be seen (usually sectors containing between 2- 20 colonies are counted).

Take the median of dilution 10^{-5} add calculate the colonies in one ml cfu/ml according to the equation Martin et al., (2007):

The following equation is used to calculate the number of colony forming units (CFU) per ml from the original aliquot/ sample:

CFU per ml = Average number of colonies for a dilution x 50 x dilution factor.

3.8 Statistical Analysis:

All the Data presented as Means standard deviation (std) was subjected tone way analysis of variance (ANOVA) ($P<0.05$)). All Statistical calculations were performed with (SPSS) (version 16.0) computer Program Gomez and Gomez (1984).

CHAPTER FOUR

4-RESULTS

4.1 Chemical analysis:

Table 2: chemical analysis of beef sausage incorporated with different levels of gum Arabic (Mean±S.E.)*

parameters	Sample A (0%)	Sample B (1)	Sample C (2%)	Significal
Moisture(%)	61.00±1.00c	63.00±1.00b	64.00±1.00a	*
Protein (%)	18.5±.10a	18.1±.15c	18.3±.10b	*
Fat (%)	3.1±.12c	3.3±.10b	3.4±.10a	*
Ash (%)	1.3±.06c	1.5±.10b	1.7±.10a	*

N= 3/replicate

*= significant differences at $p< 0.05$

Different superscript letters with in the same column means significant differences at $p<0.05$

The Results showed in **Table (2)** there was an increased in moisture, fat and ash with the increasing levels of gum Arabic % how ever the protein decreasing level of gum Arabic % .

The results there were significant differences ($p<0.05$) in, moisture , protein, fat and ash between the three treatment with the control having the best the same trend

The control samples (0%) have the best moisture, protein , fat and ash followed by B and C samples .

4.2 Physical analysis

Table (3) Physical analysis of beef sausage incorporated with different levels of gum Arabic (Mean ±S.E.)*.

Parameters	0% sample (A)	1% sample(B)	2% sample (C)	Significal
pH%	5.5±.07a	5.4± .07b	5.1±07c	*
Water holdingcapacity %	21.00±1.0b	23.00±1.0a	19.00±1.0c	*
Cooking Loss %	63.00.±1.00a	62.00± 1.00b	61± 1.00c	*

N= 3/replicate

*= significant differences at p< 0.05

Different superscript letters with in the same column means significant differences at p<0.05

The results to show in **Table (3)**, there were decrease in pH and cooking loss, with the increasing levels of gum Arabic % .There were significant differences $p<0.05$ in pH and cooking loss between the three treatment with the control having the best the same trend is a ppliced .The control samples (0%) have the best in followed by B and C samples. There was increase in water holding capacity with increasing levels of gum Arabic. There was significant differences $p<0.05$ in water holding capacity between the three treatment with the control samples (A) has the best water holding capacity the same trend is appliced followed B and C samples.

4.3 Microbial analysis:

Table (4): Microbial analysis of beef sausage incorporated with different levels of gum Arabic (Mean±S.E.)*.

Storage period	A(0%)	B (1%)	C (2%)	Signifiacl
0	9.7±1.2a	7.0±1.0b	5.5±.7c	*
7	7.7±.6a	3.3±.6c	3.7±.6b	*
14	5.7±.58b	4.3±1.5c	7.0±1.0a	*
21	4.3±1.2b	4.7±.6a	3.3±.6c	*

N=3/replicate

*= significant differences at $p< 0.05$

Different superscript letters with in the same column means significant differences at $p<0.05$

The Results to show in **Table 4** there were significant diferenies $p< 0.05$ in total bacterial count between the treatment, with the C samples (2%) having the best bacterial count the same trend is applced , (C) has the best followed by B and A sample , there was decreased bacterial count with the increasing levels of gum Arabic % .

4.4 Sensory evolution:

Table (5): sensory evolution of beef sausage incorporated with different levels of gum Arabic.

Parameters	0% sample A	1% sample B	2% sample C	significal
Colour	2.00±.82c	2.4±1.21b	2.5±1.34a	N.S
Texture	2.00±.73c	2.3±1.46	3,00±1.597a	**
Flavor	1.5±.72c	2.2±.95b	2.5±1.18a	**
Juiciness	2.00±1.3c	2.00±1.67b	2.7±1.9a	*

N=3/replicate

NS non significant

*= significant difference at $p< 0.05$

**= significant difference at $p<0.01$

Different superscript letters with in the same column means significant differences at $p<0.05$

The Results to show in **Table 5 there** was non significant difference ($p>0.05$) between the three samples in color, the control sample (0%) has the best color followed by B and C sample. About the texture and flavor there were Significant difference ($p<0.01$) in texture and flavor between the three treatment with the control having the best texture and flavor followed by B and C. The same trend is applced to juiciness, there was significant difference ($p<0.05$) between the three samples in juiciness, the control sample (0%) has the best juiciness followed by B and C.

CHAPTRE FIVE

5-DISCUSSION

In the present study the results showed that the physical–chemical properties of the three samples of sausage products significant difference ($p<0.05$) when used in the three samples of beef meats incorporated with different level of GA (Table 1 and 2) (0% , 1% and 2%).

The results showed that the physical – chemical properties of three sample of sausage products demonstrated is significantly difference ($p<0.05$) when used in to the three sample of beef meat (0%, 1% and 2%). Chemical Properties: Moisture percentage showed significant different ($p<0.05$) among control and treatment products. Although there was slight increase in moisture content with increasing levels of GA, which might be due to Gum Arabic improved moisture retention of SSMP (Chen et al., 2007). The result is disagree with the findings of (Heena Sharma et al., 2014). Moisture percentage showed no significant difference ($p>0.05$) between control and treatment products, although there was slight increase in moisture content of ERMC with increasing levels of GA, which might be due to increased water retention by bind enhanching agent .protein percentage showed significant differences ($p<0.05$) among control and treatment produces. Although there was decrease in protein content with increasing level of GA ,Which might be due to gums are high molecular weight substances ,Which in appropriate solvent (Annison et al., 1995).The result is in disagree with the finding of(Heena Sharma et al., 2014) there was no significant difference ($p>0.05$) in protein percentage between control and treatment products. Among the treatments, expected due to the replacement of lean meat with polysaccharide rich gum. There was significant difference ($P<0.05$) in fat percentage among control and treatment products, Among the treatments values were noticed with increasing levels of GA, which might be expected due to the replacement of meat with polysaccharide rich gum (Savary et al., 2010). The

present result is in agreement with the finding of Astudy of (Heena Sharma et al 2014) there was no significant difference ($p>0.05$) in fat percentage among control and treatments gradual decline in mean values were noticed with increasing levels of GA, which might be expected due to the replacement of lean meat with polysaccharide rich gum (Savary et al, 2010). Ash content recorded was significant difference ($p<0.05$) between control and all treatment products. However, a slight increase in ash percent was obtained on addition of GA which could be attributed to high mineral profile of gum (Mhinzi et al., 2008). The present result is in disagreeing with the finding of Astudy of (Heena Sharma et al 2014) in ash content recorded non – significant difference ($p>0.05$) between control and all treatment products. However, a slight increase in ash percent was obtained on addition of GA which could be attributed to high mineral profile of gum (Mhinzi et al., 2008).

Phiscal Properties,. Product pH of treatment products were decrease with increase in levels of GA which could be GA is a water –soluble gum and widely used to exploit its beneficiary effects encapsulation properties (Motlagh et al., 2006) . The present result is in disagreeing with the finding of (Heena Sharma et al 2014).product pH of Treatment products were almost same and did not differ significantly ($p<0.05$) from product. This could be expected due to the neutral pH of gum. Water Holding Capacity percentage showed significant difference ($p<0.05$) among control and treatment products although there was sligh an increase in water holding capacity control with increasing levels of GA, which might be de to increased water relention by bind enhancing agent (Savary et al 2010).cooking loss percentage recorded decrease with increase in levels of GA, Which could be important properties of sausage products as it is related to water holding capacity. There is variation in water holding capacity among different types of meat from different animal and muscles (Lawrie, 1991). The present result is in

agreeing with the finding of (Heena Sharma et al 2014) cooking yield percentage recorded marginal increase with increase in levels f GA, which could be attributed to its water holding capacity (Munoz et al., 2007)

In the study of total bacterial count in the different level of AG there were best siginfical in GA in level 2% to show decrease the number of bacterial when we increase the time which be due to the property of GA is coated by thin film (Josebau and Ullmann 1990).

Sensory evaluation: Colour values was no sig~~nificantly~~ difference ($p>0.05$) between control and treat ment was increase in treatment might be attributed to uniform color distribution of product (Glicksman, 1979 and Elizalde, et al., 1988), color value disagree with the finding of (Heena Sharma et al 2014) the results for color values , Redness of product incorporated with 1.5% GA was significantly higher ($p<0.05$) than control which might be due to interaction between meat ingredients and bind enhancing agent . The Texture of products was significant ($p<0.05$) and increase in treat meant which de to be intrinsic viscosity of gum acacia (Savary et al., 2010) the present result is in agreement with the finding of (Heena Sharma et al 2014). flavor of control and treatment products show significant difference ($p < 0.05$) a slight increase in trend was noticed for sensory attributes on addition of GA which de to ingredient and Application of GA as a fixative for flavour (Glicksman, 1979-Elizalde et al., 1988), The present result is disagree with the finding of (Heena Sharma et al 2014) general appearance flavor of control and treatment products did not showed any significant difference ($p>0.05$). However, a slight increase in trend was noticed for both sensory attributes on addition of GA. Juiciness of control and treatment products show significant difference ($p<0.05$) increase in juiciness of product with increasing levels of GA which could be attributed to moisture retention (Savary et el, 2010). The present result is in agreement with the finding of

(Heena et al 2014).gradual increase in juiciness of product with increasing levels of GA which could be attributed to moisture retention.

CHAPTAR SIX

Conclusion

Usage of gum arabic in sausages resulted in increased chemical and physical characteristics, however sensory parameter were generally accepted by the panelisls of the products and d improve the shelf life of sausages. 2% level of gum arabic was considered optimum level for preparation of sausages and could be successfully added as bind enhancing agent in beef meats. There fore in corporation of GA in to beef meats formulation will improve the binding and texture as well as a acceptability of the products, which will make the product processing economically viable.

Recommendation

Desired level of gum Arabic to be added to sausage recipe. Which was acceptable to panelists.

More research is needed for the application of gum Arabic in processed meats

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Appendix

Appendix Grading chart for sausage

Evaluate these samples for color, texture, flavor and Juiciness, for each sample, use the appropriate scale to show your attitude

By cheching at the point that best describes your feeling about the sample. If you have any question please ask.

Name:-…… Date:-……..

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

BY:-

Color	**Texture**	**Flavor**	**Juiciness**
1/ Extremely Desirable 2/Very Desirable 3/Moderately Desirable 4/Slightly Desirable 5/ Slightly Undesirable 6/ Moderately Undesirable 7/ Very Undesirable 8/Extremely Undesirable	1/Extremely Desirable 2/Very Desirable 3/ Moderately Desirable 4/Slighty Desirable 5/ Slightly Undesirable 6/Moderately Undesirable 7/Very Undesirable 8/Extremely Undesirable	1/Etremely Desirable 2/Very Desirable 3/Moderately Desirable 4/Slighty Desirable 5/Slight Undesirable 6/Moderately Undesirable 7/Very Undesirable 8/extremely Undesirable	1/Extremely Desirable 2/Very Desirable 3/Moderately Desirable 4/Slightly Desitable 5/ Slightly Undesirable 6/Moderately Undesirable 7/Very Undesirable 8/Extremely Undesirable