

Sudan University of science and technology

College of graduate studies

**Effect of partial Substituting Beef by Chicken
Gizzards on Quality Attributes of Beef Sausage**

تأثير الإحلال الجزئى للحوم الأبقار بقوانص الدجاج

فى خواص جودة السجك البقرى

Complementary Thesis submitted in partial fulfilling of the Requirement for the Degree of M.Sc. In Tropical Animal Production.

By:

Hassan Elsaddig Hassan Ali

(B.Sc Animal production 2004)

Supervisor:

Dr. Maha Mubarak Mohammed Ahmmed

Department of Meat science and technology - college of Animal production science and technology.

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الاستهلال

قال تعالى :

(قَالُوا سُبْحَانَكَ لَا عِلْمَ لَنَا إِلَّا مَا عَلَّمْتَنَا إِنَّكَ أَنْتَ الْعَلِيمُ الْحَكِيمُ)

صدق الله العظيم

سورة البقرة الآية (32)

Dedication

To my lovely family

To the best mother in the world

To my father's soul

To my brother s and sisters

To my relatives

To my colleagues

I dedicate this work.

Acknowledgements

My all thanks to God, and then after I would like to express my appreciation and my great thanks to my supervisor Dr. Maha Mubarak Mohammed Ahmmed for her continuous guidance, valuable advice and unfailing help during the period of the study.

Special thanks are due to Teachers Abu bakr Ali, and Teacher. Tarig Mustafa Mohammed (Okair) for their valuable help.

I am grateful to the college of Animal Production Department of Meat Science and Technology students and teachers forgiving me great help during this research. Thanks are extended to the staff members and technicians for the provision of facilities and help.

My thanks are also extended to the graduate students in the college of Animal Production group number (5).

List of Contents

Content	Page
الاستهلال	I
Dedication	II
Acknowledgement	III
List of Content	IV
List of Table	VII
List of Figures	VIII
English Abstract	IX
Arabic Abstract	X
Chapter One	1

Introduction	1
Chapter Two	4
Literature review	4
2.1 Meat and human consumption	4
2.2 Camel meat	6
2.3 Chevon meat	8
2.4 Gizzards	8
2.5 Sausage as meat product	10
2.5.1 Sausage manufacturing	10
2.5.2 Sausage classification	10
2.5.3 Types of sausage	11
2.6 Sausage ingredients	12
2.6.1 Meat	12
2.6.2 Casings	12
2.6.3 Non meat ingredients (additives)	12
2.6.3.1 Salt	13
2.6.3.2 Ice or cold water	13
2.6.3.3 Binders and extenders	14
2.6.3.4 Seasonings	14
2.7 Meat quality attributes	14
2.7.1 Color	15

2.7.2 Tenderness and Juiciness	15
2.7.3 Flavor and aroma	16
2.7.4 Water holding capacity (WHC)	16
2.7.5 Cooking loss	17
2.7.6 Meat microbiology	17
Chapter Three	19
Materials and Methods	19
3.1 Beef preparation	19
3.2 Chicken gizzards preparation	19
3.3 Ingredients	20
3.4 Casings	21
3.5 Treatments formulation	21
3.6 Preparation of sausage	21
3.7 Sensory evaluation	22
3.8 Proximate Analyses	22
3.9 Cooking losses	22
3.10 Shrinkage determination	23
3.11 Water holding capacity	23
3.12 Total account of bacteriological	24
3-13 Financial cost determination	24
Chapter Four	27

Results and Discussion	27
4.1 Proximate Analyses	27
4.2 Sensory evaluation	31
4.3 Physical Properties and total a count of bacterial	35
4.4 Recipe cost	39
Chapter Five	42
Conclusions and Recommendation	42
References	43
Appendices 1 Grading chart for sausage	56
Appendices 2 chicken gizzard	57

LIST OF TABLES

Table	Title	Page
3.1	Ingredients based on total mixed base	20
3.2	first treatment (A)	26
3.3	Second treatment (B)	26

3.4	third treatment (C)	26
4.1	Mean values and their standard deviation (SD) for Dry Matter, Crude Protein, Fat content and Moisture content of various treatments	29
4.2	Mean values and their standard deviation SD for sensory evaluation	33
4.3	Mean values and their standard deviation SD for some physical and TBC	37
4.4	Recipe cost of sausage treatments	41

List of Figures

Figures	Title	Page
1	Mean values and their standard deviation (SD) for Dry	30

	Matter, Crude Protein, Fat content and Moisture content of various treatments	
2	Mean values and their standard deviation (SD) for sensory evaluation	35
3	Mean values and their standard deviation (SD) for some physical and TBC	39
4	Recipe cost of sausage treatments	40

English Abstract

This study was conducted to investigate the effect of substitution of chicken gizzard for beef sausage product at levels (25%, 50%) on chemical and physical characteristics, Sensory evaluation and financial cost of sausage. The formulation of

sausage was done with three treatments as (A) control (0% chicken gizzard + 100% beef), (B) (25% chicken gizzard + 75% beef), (C) (50% chicken gizzard + 50% beef).

The proximate analysis of the sausage showed no significant differences among the treatments in the protein and fat content, however there was significant difference among the treatments in dry matter, moisture and ash content.

The Sensory evaluation results showed no significant differences among the treatment in color, texture, flavor, juiciness, and overall acceptance. On The other hand the physical characteristics results showed that, there was significant difference in water holding capacity, but there was no significant difference among the treatments in shrinkage, cooking loss and total bacterial count.

For the financial cost the study revealed that sausage processed from chicken gizzard with beef has lower price than beef, camel and chevon sausages compared with market price.

Arabic Abstract

ملخص الاطو حة

أجريت هذه الدراسة لدراسة تأثير إحتلال قوانص الدجاج لوم الأبقار عند مستويات (25% ، 50%) على الخواص الكيميائية و الفزيائية و التقييم الحسي، و التكلفة المالية للسجك المنتج. و قد تم تقسيم التوبة الى ثلاثة معاملات (A) الكنتول (0% قوانص الدجاج +100% لوم الأبقار)، (B) (25% قوانص الدجاج + 75% لوم الأبقار)، (C) (50% قوانص الدجاج + 50% لوم الأبقار).

أظهرت نتائج التحليل التقيي للسجك المنتج عدم وجود فروق معنوية بين المعاملات في البروتين و الدهن، و لكن كان هناك فرق معنوي بين المعاملات في المادة الجافة، و الرطوبة و الرماد.

و أظهرت نتائج التقييم الحسي عدم وجود فروق معنوية بين المعاملات في اللون، و القوام، و النكهة، العصرية، و رجة القبول الكلية.

كما أظهرت نتائج الخصائص الفزيائية وجود فروق معنوية بين المعاملات في القدرة على الاحتفاظ بالماء، و لكن لم يكن هناك فروق معنوية بين المعاملات في الانكماش، و فقدان الطبخ و العد الكلي للبكتيريا.

أما بالنسبة للتكاليف المالية، أظهرت الدراسة أن السجك المصنعة من قوانص الدجاج مع اللحم البقوي اقل سعواً من سجك لوم الأبقار و الإبل و الماعز مقارنة مع سعر السوق.

Chapter One

Introduction

Sudan has largest population of animals in Africa and among Arabic countries. Recently Ministry of Animal Resources, Fisheries and Ranges (MARFR, 2010) estimated animal population to be around 104 million heads. Although Sudan is rich in animal resources, it confronts many problems which lead to continuous increase, in animal and meat prices. These include poor natural pastures, high cost of feed ingredients and processed feed, diseases, inefficient management of stocks and high transportation costs.

Meat can be defined as the whole or part of the carcass of cattle, sheep goat, camel, buffalo, deer, hare, poultry, or rabbit (Williams, 2007).

Processed meats are products that have been altered in form, size, shape, function and palatability to provide more highly desired product by consumers. There are many different types of processing including size reduction, freezing, curing, tenderizing and forming (Acton et al., 1983; Foegeding and Ramsey, 1986; Barbut, 1995). During processing, meat is mixed with ingredients, common salt, phosphate and protein or carbohydrate binders that will bind the particles back together directly or indirectly. The mixture is formed to desired shape include various sausages, frankfurter, bologna and some meat loaves and formed shape will maintained after freezing and cooling (Romans et al., 1994; Barbut, 1995). Meat and meat products are considered as an excellent source of high quality animal protein, vitamins especially B complex, and certain minerals, especially iron; (Gracey et al., 1986) .

Most sausages are made from only skeletal muscles that are taken off the bones. A few varieties of sausage can also be made with variety of meats, such as

liver or tongue (Food Safety and Inspection Service / United States Department of Agriculture FSIS/USDA. 1995). Meat quality, especially in relation to its bacteriological load, is of special importance in the production of fresh sausages. Beef sausage is also manufactured from cheaper cuts of forequarters such as clod (Savic, 1985). For desirable color, meat from older animals which contains more myoglobin is preferred (Toldra, 2002).

It is difficult to fit sausages into one single definition since they are many and varied. Attempts, however, have been made to define sausages either by shape, type or meat content. Characteristically, 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 Food and Agriculture Organization (FAO)1985) views sausages as one of the oldest forms of meat processing in which meats go through various modification processes to acquire desirable organoleptic properties.

Increasing costs of conventional animal protein foods, have encouraged researchers to study alternative protein sources, particularly chicken gizzards that are commonly used by in direct consumption without processing.

Chicken gizzards is one of these meats which is widely available throughout Sudan and there price is lower compared to other meats, so processed to improve sensory characteristics, enhance nutritive content, decrease microbial count.

The problem of this study is that there were no previous researches in this subject although there were two studies, one on the effect of different levels of camel meat on fresh beef sausage (Mahassin2008), and the other study on the effect of storage period on quality of chevon and beef sausage.

The reason which guide to this study is the continues increase in red meat price.

The objectives of this study are :

- To study the effect of substituting chicken gizzards for beef on quality attributes of sausages product.
- To study the effect of substituting in recipe and financial cost of sausage.
- To evaluate the acceptability of new product
- Creation of good recipe and marketing for Chicken gizzard.
- Processing sausage less financial cost.

Chapter Two

Literature review

2.1 Meat and human consumption

Meat is the post-mortem aspect of a complicated biological tissue, the muscle, Chemical and biological constitution of that muscle is affected by a large number of intrinsic factors related to function. The most important of these are species, breed, sex, age, anatomical location of muscle, training or exercise, plane of nutrition and interracial variability. In addition to various extrinsic factors, these food, fatigue, fear, pre slaughter, manipulation and environmental condition before, during and after slaughter . In broad sense the composition of meat can be approximately 75% water, 18% protein, 3.5 soluble non-protein substances and 3% fat (Lawrie, 1991).

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 acids composition, components. The most important taste active components of meat are amino acids, peptides, organic acids, nucleotides and other flavor enhancer (Shahidi, 1989). Also it is a good source of iron and zinc (Bender, 1992).

Meat consists primarily of muscular tissue with amounts of fatty tissue varying not only with breed, age, sex, and diet of the animal but also with anatomical location (Lawrie, 1991).

Regarded nutritionally, meat is a very good source of essential amino acids, and to a lesser extent, of certain minerals. Although vitamins and essential fatty acids are also present, meat is not usually relied upon for these components in a well-balanced diet (Lawrie, 1991). Also meat provides calories from proteins, fats and limited quantities of carbohydrates present (Judge et al, 1990).

Since connective tissue proteins have a lower content of essential amino acids than those of contractile tissue, meat having a high percentage of collagen or elastine, will also have relatively lower intrinsic nutritive value (Lawrie, 1991).

In respect of the essential amino acids, beef would appear to have a somewhat higher content of leucine, lysine and valine than lamb, and lower content of threonine. More significant difference may exist between specific muscle locations, or that breed, and animal age, have important effect. The amino acids content may be affected by processing (e.g. heat, ionizing radiation), but unless processing conditions are both severe and prolonged, such destruction is minimal. Rather more important is the possibility that certain amino acids may become unavailable, (Bender, 1966).

Thus (Dvorak and Vognarova 1965) have found that after heating beef for 3 hours at series of temperatures, 90% of the available lysine was retained at 70 °C and only 50% at 160°C.

Meat is generally a good source of all minerals except calcium, calcium of the meat is present in bones and teeth (Judge et al., 1990) Meat is also an important source of iron, the concentration of it is markedly higher in liver than in the muscular tissue (Lawrie, 1991).

Meat is an excellent source of the water soluble B complex group but , is very poor source of the water soluble vitamin C ,and of the fat soluble vitamin A , D , E and K that are found primarily in the body fat and the variety meat (liver , kidney , heart etc ...) All meat is a very poor source of water – soluble vitamin C except when ascorbate has been added to processed meat products (Judge et al . , 1990).

2.2 Camel meat

Camel meat is palatable but coarser than beef and it had sweetish taste. (Leupold,1963, Morton, 1984, Wilson,1984). (Kurtu, 2004) stated that camel meat is regarded as a high quality food with medical value, economically and environmentally adaptable alternative source of meat (Kurtu, 2004).

Meat from camel below 5 years of age has almost the same percentage of crude protein as that of steers. While meat from camel of 5 years old or over contain a higher percentage of crude protein than beef and the crude fat and ash content comparatively lower than beef (Hisashi, 1961). Meat from young animal less than 5 years of age has higher moisture content (78.27%) percent than that of older animals (74.24 %) (Abd Baki, 1951, Hamam et al, 1962; Nasr,1965). The average of moisture in camel meat is about 64.4% to 77.7% irrespective of the different muscles or cuts (Bendny et, al, 1979); (kadima, et al, 2006). (Babiker and Yosif, 1989) studied the chemical composition of mature camel meat and found that the average moisture % was about (75-89%), (75-81%) and (75-83) for the muscles, lathmatic dorsi, semitendinosus and Triceps barnchi respectively.

Camel meat had higher moisture content (%) more than beef (Zamil.M et al, 1992).

The chemical composition of camel meat and beef were not significantly different but the camel meat score was higher in moisture (69-73%) (Mohammed, 1993). Camel meat had highest percentage of moisture content (75-78%) while beef meat had lowest % (73-75%) (Dawood, 1996). (Saliha, 2001) studied the tenderization of desert camel meat and found its moisture content was about (71.01%) in composition so that it is attractive to developing countries (Sales,1995). Age has influence on the fatty acid composition and melting point of hump and abdominal fat (Kodima et al, 2006).

Camel muscle has a low fat percentage (1.36%) in comparison with beef muscle (2.99%) (Mahassin, 2008). The mean fat percentage of camel meat is (1.1-1.5) therefore it is much leaner than meat produced by other species (Suad, 1994, Kadima et al, 2006). Although Saliha (2001) reported that the fat content was about (2.94). (Williams, 2007) reported that the fat content of camel meat was considerably less than beef. Proteins are the source of essential amino acid in human diet. Camel meat had generally lower protein content than beef about 19.4% to 22.05% (Suad, 1994, Saliha 1997, Kadima et al. 2006) without significant difference between the sexes and also lower in their biological value in histidine, tryptophan, valine and leucine-isoleucine mixture (El.Iragi, 1970). Chemically, camel meat had significantly lower sarcoplasmic protein and non protein nitrogen than beef (Babiker and Yosif,1989) and have higher percentage of amino acids than the other red meat and lower tryptophan, spartic acid and tyrosine (Mohammed, 1993). (Babiker and Yosif,1989) found that the average protein content of L.dorsi 21.63 %, semitendinous 21.14 % and triceps brachii 22.13 % , also reported that the

concentration of sarcoplasmic and myofibril protein were not significantly different among the three muscles. The proximate composition of the beef meat was 21.26 % protein 76.56%moisture and 1.0% to 3% fat (Nesimi Aktas et. al, 2003).

The age of camel had influence in the ash content it ranged from 0.76% of young animal to 0.86% of older ones (Nasr, 1965). Also the ash content differed among the different muscles, lathmatic dorsi (L.dorsi) 1.05% semitendinous 1.38% and tricepsbarchii 1.22% (Babiker and Yosif, 1989). Camel meat is lower in ash content than beef and had similar content of the element composition to the beef (El-Gasim, and Alkanhal, 1992). The average mean percentage of camel muscles ash content is 1.0% - 1.1% (Mohammed,1993; suad,1994; saliha, 1997; kadima et al. 2006).

2.3 Chevon meat

The meat from mature goats is used primarily in processed foods such as sausage or chili. American Meat Gout Association (AMGA, 2008).

Chevon has been established as a lean meat with favorable nutritional qualities, and it's an ideal choice for the health-conscious consumer. For example a 3 ounce cooked portion of lean goat meat when compared to a similar weight of beef containing 122, 180 calories would provide 2.6, 7.9 gm of fat with 0.79, 3 gm of saturated fatty acid and 63.8, 73.1 mg of cholesterol respectively. United State Department of Agriculture (USDA, 2001).

2.4 Gizzards

Some birds contain an organ called the gizzard, which aids digestion in the bird by helping to grind hard foods, such as seeds, you can eat the gizzards from chickens and turkeys, and they may provide some health benefit. (Natalie 2011).

A 100-g serving of chicken or turkey gizzard has 69 to 71 mg of sodium, which means that it is a low-sodium food, according to the Mayo Clinic. A high-sodium diet can cause high blood pressure and increase your risk for heart disease. Healthy adults should have no more than 2,300 mg per day, according to the 2010 Dietary Guidelines from the U.S. Department of Health and Human Services. Gizzards are lower in sodium than prepared meats, such as cold cuts, sausages or bacon (Natalie 2011).

Chicken gizzard has 2.5 mg of iron, or 14 percent of the daily value, and turkey gizzard has 4.3 mg, or 24 percent of the daily value, in a 100-g serving. Iron is an essential mineral for healthy red blood cells, and a deficiency can cause anemia. The iron that you get from animal products, such as gizzards, is in the form of heme iron, which is easier for your body to absorb than the non-heme iron from plant-based foods, such as spinach and beans (Natalie 2011).

A 100-g serving of chicken or turkey gizzard supplies nearly 3 mg of zinc, or almost 20 percent of the daily value of this essential mineral, which is necessary for a healthy immune system. The gizzard promotes heart health because it is an excellent source of selenium, which supports the antioxidant activity of vitamins C and E in your body. Choline is another heart-healthy nutrient in gizzard. Gizzard is a good natural source of niacin, or vitamin B-3, vitamin B-12 and vitamin B-6, (Natalie 2011).

Chicken gizzards are an excellent source of high quality protein, with 30.3 g per serving. This amount meets a significant portion of your daily requirements of

46 to 56 g per day. Protein benefits your immune system and aids in tissue repair. Gizzard protein provides all the essential amino acids, (Nicole 2011).

2.5 Sausage as meat product

The term sausage came from Latin word (salsus) meaning salt or literally translated refers to chopped or minced meat preserved by salting (Pearson and Tauber, 1984). Sausages are very common and popular meat products manufactured from lower-value trimmed meat to produce higher value products (Ockerman, 1986; Jihad et al., 2009). It is difficult to define sausage in single definition due to the variety of different types. Sausage can be defined as comminuted processed meat product made from red meats, poultry or combination of these with water, binders and seasoning (Dytte et al., 1981; Essien, 2003). Sausage is prepared food, usually made from ground meat animal fat, salt, spices (sometimes with other ingredients such as herbs), typically packed in a casing (Jihad et al., 2009).

2.5.1 Sausage manufacturing

Sausage making and manufacturing is a continuous sequence of events. Each step in proper sequence is important to successful operation in studying sausage processing; it is convenient to separate the process into four basic processing: selecting ingredient, grinding, mixing and thermal processing (Pearson and Gillett, 1996).

2.5.2 Sausage classification

Sausage 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 these are fresh sausage, uncooked smoked sausage, cooked smoked sausage, and cooked sausage, dry and semi-dry sausages (Dytte et al.,1981).

Classification of sausage is commonly based on the type of the meat ingredients and processing methods used in their manufacture. Some product may be made from meat of only one specie; however it's very common to use two or three types of red meat and poultry ingredients in many sausage formulations (Dytte et al.,1981).

2.5.3 Types of sausage

Sausage is made from beef, veal, pork, lamp, poultry and wild game, or from any combination of these meats. Sausage making has become a unique blend of old procedures and new scientific, highly mechanized processes. Traditionally, sausage was formed into asymmetrical shape, but it now can be found in variety of shapes and sizes to meet consumer's needs. Many sausage products are vacuum packed, freshness dated and 100% edible. Sausage can be classified in a variety of ways, but probably the most useful is by how they are processed Fresh sausage, Uncooked thoroughly smoked sausage, Cooked smoked (Frankfurter) sausage, Dry sausage, semi-dry (bologna) sausage and cooked meat (Loaves, head) specialties (Martin and Julie, 1998).

Emulsion type sausage is technologically dependent upon the protein and their water binding and emulsifying properties. Muscle protein can be divided into three groups, based on their solubility characteristics, sarcoplasmic (water-soluble),

myofibril (salt-soluble) and stromal (insoluble) protein (Xiong, 1997) . Myofibril protein, of which myosin and actin are the most abundant, are most important during meat processing because of their ability to produce three-dimensional gels upon heating and subsequent cooling, which has a high influence on the yield and texture properties of processed meat products (Smith,1988); (Vega et, al, 1999).

2.6 Sausage ingredients

2.6.1 Meat

Meat can be defined as the whole or part of the carcass of any cattle, sheep goat, camel, buffalo, deer, hare, poultry, or rabbit, (Williams, 2007).. A few varieties of sausage can also be made with variety meats, such as liver or tongue. Food Safety and Inspection Service United State Department of Agriculture (FSIS/USDA.1995). Meat quality, especially in relation to its bacteriological load, is of special importance in the production of fresh sausages. Beef sausage is also manufactured from cheaper cuts of forequarters such as clod (Savic, 1985). For desirable color, meat from older animals which contains more myoglobin is preferred (Toldra, 2002).

2.6.2 Casings

Casings are used as containers for sausage to give them shape and to hold them together during further processing. There are two types of casing: natural and manufactured. The natural casings are derived from gastro-intestinal tract of sheep, goats, swine and cattle. The manufactured casings have four classes, edible collagen, inedible collagen, cellulose and plastic (Judge et al., 1990)

2.6.3 Non meat ingredients (additives)

Food additives are used to accomplish certain functions such as coloring, antimicrobial, antioxidant, preservation, improved nutrition, increased emulsification and altered flavor (Ockerman, 1986; Jihad et al., 2009).

2.6.3.1 Salt

Salt is the most common and most important non meat ingredient of sausage. Its function includes flavoring, preservation and production of proper texture by solubilization of meat proteins. Maintaining color stability and minimizing bacterial growth can be achieved satisfactorily by using alternatives binders to salt, that do not accelerates the of metmyoglobin, bacterial growth can be minimized by using sodium bisulphate (Savic, 1985; Bender, 1992; Judge et al., 2001; Kerry et al., 2002). Salt is powerful preservative at high concentration, but at low concentration it develops a desirable flavor in the processed meat products. Salt is added for flavoring function at concentration between 2-3 %. Fresh sausages generally have a lower salt level due to detrimental color effects, 1.5 % salt in finished sausage works out satisfactorily for color and flavor (Baumgartner, 1985).

2.6.3.2 Ice or cold water

Water or ice added to the meat mixture provides considerable functional qualities. It chills the meat during the chopping or mixing operations, which give longer and more efficient churning of meat mass without mechanical overheating. It aids in dissolving sodium chloride and curing salts to give better distribution in the mixture. Also it imparts fluidity to the meat mixture or emulsion that aids in proper filling of the casings. Moreover, the added water content markedly affects texture

and tenderness of finished sausages (Pearson and Gillett, 1996). According to Sudanese Standards and Metrology Organization (SSMO 2008) the level of added water should not exceed than 10 % in the fresh sausage.

2.6.3.3 Binders and extenders

Non-meat proteins are widely used in meat processing. Non-meat proteins used in meat processing technology divided into two groups: (1) plant proteins such as soy isolates, soy concentrates and flours (2) protein of animal origin such as milk proteins. Soy products 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 Barbut, (1993); Pietrasik and Duha, 2000; Porcella et al., 2001); Dolata and Piotrowska, (2002); Meltem and Meltem, (2003). Milk proteins can act both as emulsifier and as water and fat binders in foods (Sebranek, 1996).

2.6.3.4 Seasonings

Seasonings influence the flavor, appearance and shelf-life of the product; they are classified further as spices, herbs, aromatic vegetables, flavoring enhancers and stimulated meat flavors. Certain spices such as black pepper, ginger and mace have antioxidant properties and will help extend the shelf-life of sausages (Komarik et al., 1978; Pearson and Gillett, 1996). The characteristic flavor of a given type of sausage depends to a large extent on the spices used in its formulation (Toldra, 2002).

2.7 Meat quality attributes

Meat quality includes tenderness, palatability, aroma, flavor, color and juiciness. Species, sex, breed, age and post-mortem handling are known to influence these factors. It is also possible that diet or some components of diet may exert some effects on the factors mentioned above. It may lead to reduce meat quality leading to low pricing (Dikeman 1990; Koohmaraie, 1992; Glitsch 2000; Kerry et al., 2002; Egena and Ocheme 2008).

The effect of temperature of comminuting on stability and eating quality of “English” sausage. It was found that increasing temperature of comminuting leads to increased cooking loss, softening in texture and darkening in color. Subjective assessment indicated that at least up to comminuting temperature of 25°C the sausage were acceptable and at temperature above 30°C off flavor developed, (Sally, Ledward, 1984).

2.7.1 Color

Color is an important criterion of raw or cooked meat and meat products. It reflects the proper composition of the products, 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).

The presence of muscle pigments, myoglobin and haemoglobin is the main limiting factor of the meat color. Discolouration can be related to the amount of these pigments in the meat, the chemical state of the pigments and the way in which light is reflected off the meat (Adegoke and Falade, 2005). Color loss in sausage is

caused partly by oxidation of meat pigment myoglobin to metmyoglobin (Wilson, 1981). Goat meat was darker red in color than lamb (Babiker et al., 1990)

2.7.2 Tenderness and Juiciness

Tenderness and juiciness are closely related, the more tender meat the more juicy. Juiciness varies inversely with cooking loss (Lawrie, (1991); Judge et al., (2001). McMillin, (2005) reported that age, breed, and diet influence tenderness, juiciness, and flavor. As with most livestock species, the age and sex of the goat influence meat properties and relative value. Young goats generally produce more tender meat than older goats. (Kirton, (1970); Gaili et al., (1972); Riley et al., (1989), but conformation and breed may influence the effects of age on meat properties (Smith et al., 1978). The leg slices in meat from yearling goats and kid goats with low conformation were less tender than leg meat from kid goats having medium or high conformation. (Phelps et al., 1999).

2.7.3 Flavor and aroma

Meat aroma develops from the interactions of non-volatile precursors, including free amino acids, peptides, reducing sugars, vitamins, nucleotides and unsaturated fatty acids, during cooking. (Mottram, 2002). Chevon is lower in flavor than lamb and beef, and it is less strong than in lamb. (Smith et al., 1974; Babiker et al., 1990). Water-soluble precursors, including sugars, free amino acids and nucleotides, were quantified in raw and cooked goat meat, as better understand of aroma formation. When compared with the same precursors in beef, lamb and chicken, levels in goat meat were generally similar, except for some carbohydrates and amino acids such as fructose and glycine, which were present at higher

concentrations in goat meat suffered great losses during the cooking process and seem to be most involved in aroma formation in goat meat (Madruga et al., 2010).

2.7.4 Water holding capacity (WHC)

Is the ability of meat to hold its own or added water during the application of any force. Hamm, (1986). Babiker et al, (1990).

The water holding capacity of meat is an attribute of obvious importance. This is particularly so in comminuted meat such as sausage, where the structure of the tissue has been destroyed and is no longer able to prevent the aggrs of fluid released from the protein (lawrie, 1991).

The water-holding capacity of meat is affected by several factors, such as species, age and muscular function. Muscles with high content of intramuscular fat tend to have a high WHC (saffle and bratzler,1959).

2.7.5 Cooking loss

Cooking loss is one of the most important properties of emulsion type sausage products and it is related to water holding capacity. There is variation in water holding capacity among different types of meat from different animal and muscles. 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).

2.7.6 Meat microbiology

Contamination of carcass come from different sources including environment and equipments with which meat comes in contact during slaughtering and

processing, but hides remain an important source of contamination of carcass. (Stringer et al., 1969).

The total viable bacterial count of perishable foods is used to evaluate its contamination level because the bacterial load determines the shelf-life (Angelloti, 1964). Recently many vegetable proteins have been blended with different meat products. Many research workers have reported that bacterial numbers increase with the increase of the percentage of vegetable protein blended in meat products. (Tibin and Melton, 1990).

Ground beef is one of the most economical and popular choice of meat product that offer consumer variety and convenience. However, it provides an excellent environment for microbial growth and becomes contaminated as result of grinding and mixing during fabrication process. When examined for microbiological quality and shelf-life at higher temperature it was found to have significantly higher total plate counts. (Narasimha and Ramesh, 1988); Jay, 1996). (SSMO 2008) reported that for fresh sausage the total aerobic plate count should not exceed more than 5.25×10^{-5} CFU/ml.

Keeping quality of meat and meat products depends on the number of the contaminating bacteria and their metabolism and rate of growth. It also depends on the physical and chemical environment. (Brownile, 1966). The hygienic level of the methods of killing, preparing and subsequent processing meat determines the bacteriological quality of the finished product. The deterioration of food is usually manifested by alternations in the appearance, texture, color, odor and flavor or by slime formation. Degradation of food results in the formation of compounds which have odors and flavors different from those of fresh food (Jay, 1970).

Chapter Three

Materials and Methods

This study was conducted at the laboratory of Meat Science and Technology Faculty of Animal Production Science and Technology, Sudan University of Science and Technology, in 11/5/2013.

3.1 Beef preparation

A total of 6.75 kg fresh deboned beef meat was obtained from the local market. The beef was ground through 0.25 in plate of an electrical meat grinder. The whole bulk of mixed meat was thoroughly hand mixed to give a homogeneous sample. Then, it was divided into three patches 1 kg, 0.75 kg and 0.5 kg. (One batch for each treatment).

3.2 Chicken Gizzard preparation

A total of 2.25 kg fresh Chicken Gizzards were obtained from Khartoum meat market, were washed, cleaned and ground through 0.25 inch plate of an electrical meat grinder, then the bulk was divided into two batches, one treatment contained (0.25 kg) Chicken Gizzard and the other treatment contained (0.5 kg) Chicken Gizzard While the third treatment was formulated without chicken gizzard (control). (three replications were prepared for each treatment).

3.3 Ingredients

All ingredients were added equally to each treatment as shown in tabl(1).

Table 3.1 Ingredients based on total mixed base

No	Ingredient	Percentage
1	Salt	2
2	Coriander	0.4
3	Black pepper	0.3
4	Sugar	0.4
5	Cinnamon	0.1

6	Garlic	0.3
7	Skimmed milk powder	0.3
8	Potatoes	20
9	Ice water	20

3.4 Casings

Natural casings (sheep intestines) were obtained from the local market at Khartoum North in clean scraped ready form. They were salted and kept in a freezer.

3.5 Treatments formulation

Ground chicken gizzards were added to the ground beef meat to formulate three treatments:

(A) 100% beef (control), 0% chicken gizzards.

(B) 75% beef, 25% chicken gizzards.

(C) 50% beef, 50% chicken gizzards.

3.6 Preparation of sausage

Each patch was chopped separately, after formulation using the ingredients in table (1). The chopper was started after the minced meat was introduced. Salt and half of the recommended ice water were added together and uniformly dispersed. Then, the binder and seasoning were added together, with the remainder of the recommended ice water. The entire mass for each batch was chopped about 5 minutes. The batter for each patch was then stuffed into natural casings and linked at length about 7cm. The sausages were packed in polyethylene bags and stored in freezer waiting different tests.

3.7 Sensory evaluation

Ten (10) semi-trained panelists were asked to evaluate individually the treatments effect on color, tenderness, juiciness, flavor, and overall acceptability.

Samples in each treatment were taken after being cooked at (90°C) for 5 minutes and then placed in a dish which was divided into 3 portions. Every

treatment was given a random of three code numbers which were changed in each session. Every panelist had one dish to evaluate in each session under natural light. Using 8-points (hedonic scale) card (Cross *et al.*, 1978), in which the highest score of 8 being extremely desirable and 1 being extremely undesirable, tap water was available for use between testing samples for washing hands and mouth cleaning . (Appendix 1).

3.8 Proximate Analyses

Three sausage samples were taken at random from each treatment and then approximately 50 grams portions were taken from different places and mixed well to assure a representative sample for proximate analyses, and were sent to the Central Laboratory for Veterinary Research Department of Biochemistry Soba for the Proximate chemical analysis, moisture, crude protein (CP), ether extract (EE) and ash of the sausage samples were determined according to Association of Official Analytical Chemists (AOAC 1995) methods.

3.9 Cooking loss

The frozen sausage samples were thawed in a refrigerator for overnight. The sample were cooked in a pan using vegetable oil at constant temperature (90⁰c) for 5 minutes with continues turning of the samples. The cooked samples were dried of the oil using absorbent kitchen paper and allowed to cool, weighed and kept for sensory evaluation. The difference in weight of samples before and after cooking was recorded as the total cooking loss and expressed as a percentage of weight before cooking .(Nour 2003).

$$\text{Cooking loss\%} = \frac{\text{wt. before cooking} - \text{wt. After cooking}}{\text{wt. before cooking}} \times 100$$

wt. before cooking

3.10 Shrinkage determination

The frozen sausage sample of almost the same diameter was thawed in a refrigerator for overnight. The length of the samples were measured using a measuring tape then cooking a pan using vegetable oil at constant temperature (90°C) for 5 minutes with continuous turning of the samples. The cooked samples were dried of the oil using absorbent kitchen paper and allowed to cool and were re measured. The difference in the total length of samples before and after cooking was recorded as the shrinkage and expressed as a percentage of length before cooking. (Nour 2003).

$$\text{Shrinkage} = \frac{\text{Length Before Cooking} - \text{Length After Cooking}}{\text{Length Before Cooking}}$$

3.11 Water Holding Capacity (WHC)

Water holding capacity was calculated according to Alaswad (1984). The meat samples from each rib section about 0.3 g were ground and placed on a humidified filter paper (what man no 40) of known weight then the samples were pressed between two Plexiglas plates for 10 min at 1 kg load . Each filter paper was reweighed and the difference between the two weights was obtained. The water holding capacity then calculated using the following equation:

$$\text{WHC (\%)} = \text{Actual moisture (\%)} - \text{free water in sample (\%)} .$$

3.12 Total a count of Bacteria

Standard plate count agar media was used to determine the total bacterial count. Samples were prepared according to the technique described by International Commission on Microbiological Specification for Foods (ICMSF 1978). Briefly, 1 g from each sample was transferred under aseptic condition to glass tube containing 9 ml of sterile normal saline. The content of the tube was homogenized by dipping and shaking the sample to have a dilution of 10⁻¹. About 10 – 15 ml of plate count agar media poured aseptically into sterile petri - dishes. One ml from dilutions added to each petri – dish, and then they were transferred to an incubator at 37°C for 48 hours. A colony counter was used for counting colonies grown in the incubated petri – dishes. Such homogenate was used for all bacterial investigation. Further, 5 fold serial dilutions were prepared up to 10⁻⁵.

3.13 Financial cost determination

Table (8) Figure (4), determinate the financial cost of each treatment calculated including the price of all additives and materials involved in each treatment Table (2) which represents the first treatment (A) control 100% beef meat) the financial cost of 1.438 kg from sausage processed reached (39.816 SDG) this mean (1kg cost 27.688 Sudanese pound). Second treatment (B) 25 % chicken gizzard with 75% beef, the financial cost of 1.438 kg from sausage processed recorded (33.566 SDG) this mean (1kg cost 23.342 Sudanese pounds). In the third treatment (C) 25 % chicken gizzard with 75% beef meat, the financial cost of 1.438 kg from sausage processed was (27.316 SDG) this mean (1kg cost 18.995 Sudanese pound).

Cost determination.

Table 3.2 first treatment (A) Control (100% Beef)

Price/ pound	Quantity /gram	Ingredient	No
4.816	438	Additives	1
35	1000	Meat	2
-	-	Gizzards	3
39.816	1438	Total	4

Table 3.3 Second treatment (B) (75% Beef + 25% chicken gizzards)

Price/ pound	Quantity /gram	Ingredient	No
4.816	438	Additives	1
26.25	750	Meat	2
2.5	250	Gizzards	3
33.566	1438	Total	4

Table 3.4 Third treatment (C) (50 % Beef + 50 % chicken gizzards)

Price/ pound	Quantity /gram	Ingredient	No
4.816	438	Additives	1
17.5	500	Meat	2
5	500	Gizzards	3
27.316	1438	Total	4

Chapter Four

Results and Discussion

4.1 Proximate Analysis

Mean values of the effect of different substitution levels of chicken gizzard for beef on chemical composition as shown in table (5) Figure (1). There were no significant differences among the treatments in crude protein % and fat % while I found significant differences ($p \leq 0.05$) among the treatments in dry matter %, Ash % and Moisture % .

Crude protein% and fat content were higher in the sausage sample (C) which was processed from (50% chicken gizzard + 50% beef) which recorded (19.34%) protein and (3.12%) fat , while the sausage sample (B) processed from (25% chicken gizzards + 75% beef) recorded (19.19%) protein and (3.02%) fat compared to sample (A) the control (100% beef) which had the lower score (18.86%) protein and (2.93%) fat.

Table (5) and Figure (1) indicated that, there were significant differences ($p \leq 0.05$) in dry matter content among the treatments, where the sample (A) has higher DM (22.50%) compared to the sausages sample (C) (19.33%) and sausages sample (B) which has the lowest square (19.17%).

As for ash content table (5) and Figure (1) showed that, there were significant differences ($p \leq 0.05$) among the treatments so the sample (A) as (2%) had higher

percentage compared with sausages sample (C) (1.67%) and sausages sample (B) which was (1.33%).

The results of moisture content as shown in table (5) and Figure (1) indicated that, there were significant differences ($P \leq 0.01$) among the treatments, the sausages sample (B) processed from (25% chicken gizzard with 75% beef) contained the highest moisture content which recorded (81.17%). followed by that sausages sample (C) processed from 50% chicken gizzard with 50% beef which reached (80.67%) and sample (A) which recorded (77.50%).

Crude protein and fat content which was in agreement with that reported by (Mahassin 2008) who studied the effect of different levels of camel meat on fresh sausage with percentage 25% camel meat + 75% beef, 50% camel meat + 50 % beef. And she also found there was no significant difference in moisture and ash content, which was disagree with the result in this study that indicated significant difference ($p \leq 0.05$) in moisture and ash content.

In request of crude protein and fat content, although the results are disagree with that found by (Ali 2012)) who studied the effect of storage period on quality of chevon and beef sausage with percentage 50% chevon + 50% beef due to different types of meat ,but also agree with his finding significant differences ($p \leq 0.05$) in moisture and ash content.

Table 4.1 Mean values and their standard deviation (SD) for Dry Matter, Crude protein, Fat Content, and Moisture content of various treatments

Treatments	A	B	C	Significant level
Parameters				
Dry matter	22.50±2.17 ^a	19.17±0.75 ^b	19.33±1.51 ^b	**
Crude protein	18.86±0.89	19.19±0.72	19.34±0.63	NS
Fat	2.93±0.18	3.02±0.08	3.12±0.18	NS
Ash	2±0 ^a	1.33±0.52 ^b	1.67±0.52 ^a	*
Moisture	77.50±2.17 ^b	81.17±0.75 ^a	80.67±1.51 ^a	**

N=6

a, b, c: Mean having different super scripts differ significantly ($p < 0.05$)

*: significant at ($p \leq 0.05$)

** : significant at $P \leq 0.01$

NS: Not significant

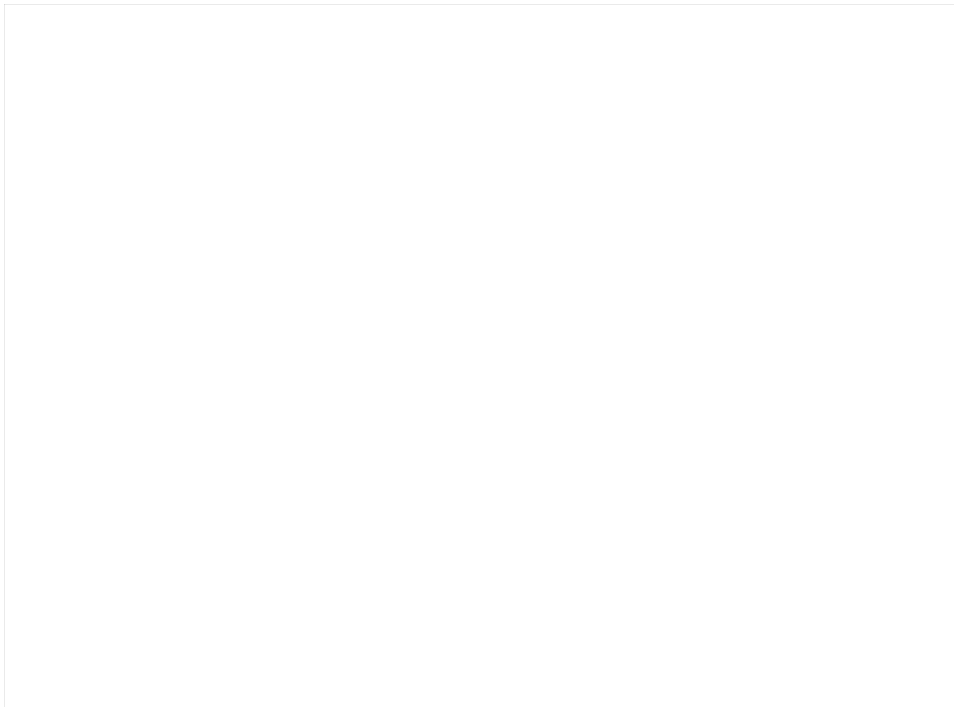
Different letters with in the same raw means significant different at $P \leq 0.05$

A: Control (100% beef).

B: (25% chicken gizzards + 75% beef).

C: (50% chicken gizzards + 50% beef).

Figure (1) Mean values and their standard deviation SD for Dry Matter, Crude protein, Fat Content, and Moisture content of various treatments



A: Control (100% beef).

B: (25% chicken gizzards + 75% beef).

C: (50% chicken gizzards + 50% beef).

DM: Dry Matter.

CP: Crude Protein.

MOIS: Moisture

4.2 Sensory evaluation

As shown in table (6) and Figure (2) There was no significant difference among the treatments in Color, texture, flavor, juiciness, and Overall acceptability.

The Color values for all the sausage samples indicated that there was no significant difference among the treatments table (6) and Figure (2). However the sausages samples (B) and (A) had equal scores (6.67), while sausages sample (C) less than other treatments (6.60).

As for texture there were no significant differences among the treatments in texture as shown in table (6). The sausage sample (B) had the highest score (6.63)

followed by the sausage sample (C) which reached (6.57) and the sausage sample (A) had the lowest score (6.50).

Table (6) Figure (2) revealed that there was no significant differences among the treatments in flavor. However, the sample (B) which had the highest score (6.57) and sample (C) which recorded (6.43) which lower score than the (A) control 100% beef (6.60).

The juiciness was not significantly different among the treatments, where sausage sample (C) had the lowest juiciness score (6.33) followed by sausage sample (B) which recorded (6.50), while the sample (A) control had a higher score reached (6.67).

For the Overall acceptability in table (6) Figure (2) there was no significant difference among the treatments. The samples (A) and (B) had the same score (6.70) higher than the sausage sample (C) which recorded (6.57).

This results are agreement with that found by (Mahassin 2008), and (Ali 2012) who reported no significant differences in color, Texture, flavor, juiciness and acceptability. In general there was decrease in mean value for color, flavor, and juiciness in over all acceptances in sample (c) 50% chicken gizzard + 50% beef compared to the other treatments.

Table 4.2 Mean values and their standard deviation (SD) for sensory evaluation.

Treatments	A	B	C	Significant level
Color	6.67±0.92	6.67±0.88	6.60±1.04	NS
Texture	6.50±1.07	6.63±0.96	6.57±1.10	NS
Flavor	6.60±0.81	6.57±1.01	6.43±1.01	NS
Juiciness	6.67±0.76	6.50±1.07	6.33±1.06	NS

O v e r a l l acceptance	6.70±0.84	6.70±0.99	6.57±1.07	NS
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N=10

NS: Not significant

A: Control (100% beef).

B: (25% chicken gizzards + 75% beef).

C: (50% chicken gizzards + 50% beef).

Figure (2) Mean values and their standard deviation SD for sensory evaluation



(A) Control (100% beef).

(B) (25% chicken gizzards + 75% beef).

(C) (50% chicken gizzards + 50% beef).

4.3 Physical Properties and total a count of bacteria

Table (7) and Figure (3) showed that, there were significant differences ($p \leq 0.05$) among the treatments in water holding capacity. The sausage sample (A) had a higher percentage (23.33%) followed by sausage sample (C) which recorded (21.11), and sausage (B) which recorded (20).

With regard to shrinkage, table (7) Figure (3) the results revealed that, the samples were not significantly different. The sausage sample (B) had the higher score reached (21.95) while the sausage sample (A) recorded (20.73), and the sausage sample (C) had the lower score reached (20.48).

As shown in table (7) Figure (3) the results of Cooking loss were not significantly different ($p \leq 0.05$) among the treatments, the sausage sample (B) recorded higher score (23.81) followed by the sausage sample (A) which recorded (23.68) and at last the sausage sample (C) which recorded (21.91).

There was no significant difference among the treatments in Total Bacterial Count (TBC). Addition of chicken gizzard slightly increased Total Bacterial Count of the sausage sample (c) as shown in table (7) Figure (3).

The results in table (7) Figure (3) cleared that, there were no significant differences among the treatments in total bacterial count which Agree with Ali (2012) who reported no significant differences among the treatments.

This results agree with that stated by (Mahassin 2008) who found no significant differences in shrinkage, but disagreement with (Ali 2012) who studied the effect of storage period on quality of chevon and beef sausage and reported significant differences and this may be attributed to different cooking methods used.

For Cooking loss% the results disagreement with (Mahassin 2008) and (Ali 2012) who reported significant differences in their studies.

As for the W.H.C the results in table (7) figure (3) showed significant difference's among the treatments which was agree with that reported by (Mahassin 2008) and (Ali 2012) who found the same result in their studies. However the sample (A) 100% beef control recoded the higher value compared to the other two samples.

On the other hand the Beef sausage (control) was lower in total bacterial count ($\log 6.25 \log_{10} \text{CFUg}^{-1}$) compared to (chicken Gizzard with beef) sausage samples (B) and sample (C) with ($6.41 \log_{10} \text{CFUg}^{-1}$), ($6.47 \log_{10} \text{CFUg}^{-1}$) respectively, that may be attributed to the previous contamination of chicken gizzard.

This results agree with that stated by (Mahassin 2008) who found no significant differences in shrinkage, but disagreement with (Ali 2012) who studied the effect of storage period on quality of chevon and beef sausage and reported significant differences and this may be attributed to different cooking methods used.

For Cooking loss % the results disagreement with (Mahassin 2008) and (Ali 2012) who reported significant differences in their studies.

As for the W.H.C the results in table (7) figure (3) showed significant difference's among the treatments which was agree with that reported by (Mahassin 2008) and (Ali 2012) who found the same result in their studies. However the sample (A) 100% beef control recoded the higher value compared to the other two samples.

Table 4.3 Mean values and their standard deviation SD for some physical and TBC

Treatments	A	B	C	Significant level
Parameters				
Water holding capacity %	23.33±0 ^a	20±0 ^b	21.11±1.92 ^b	*
Shrinkage %	20.73±1.27	21.95±0.46	20.48±0.83	NS
Cooking loss %	23.68±2.28	23.81±2.06	21.91±0.96	NS
TBC CFU 10 ⁻⁵ ml ⁻¹	1.93±0.81	2.87±1.45	3.07±0.95	NS
TBC CFU/log ⁻¹	6.25±0.22	6.41±0.28	6.47±0.15	NS

TBC= Total Bacterial Count

N=3

*: significant at P<0.05

NS: Not significant

Different letters with in the same row means significant different at $P < 0.05$

(A) Control (100% beef).

(B) (25% chicken gizzards +75% beef).

(C) (50% chicken gizzards +50% beef).

Figure (3) The Mean values and their Standard Deviation for some physical and TBC



WHC : Water holding Capacity

CL : Cooking Loss

TBC : Total bacterial count

A: Control (100 % beef).

B: (25% chicken gizzards + 75% beef).

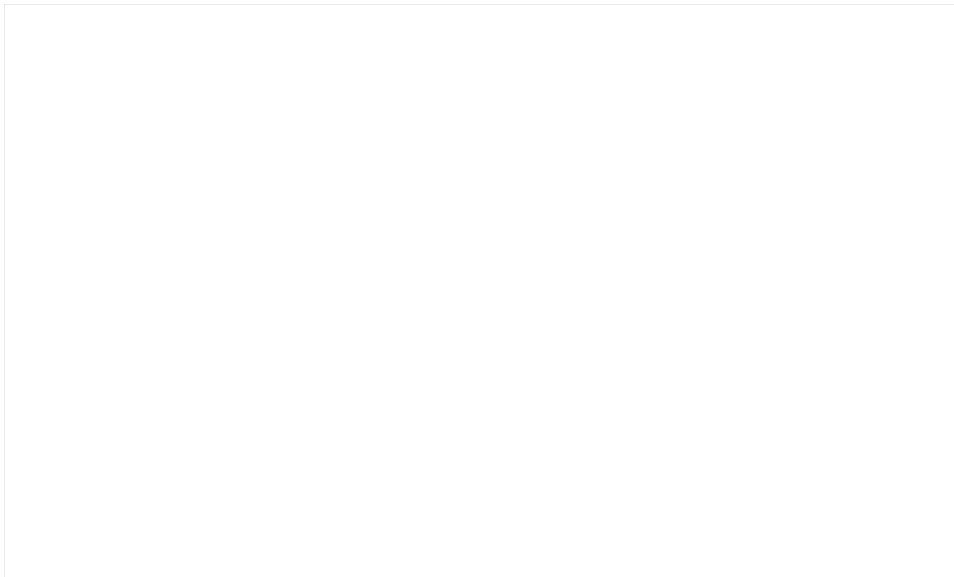
C: (50% chicken gizzards + 50% beef).

4.4 Recipe cost

As shown in table (8) Figure (4), the economical cost for the three samples (A), (B) and (C) is 39.816 , 33.566 and 27.316 Sudanese pound respectively. The additives costs are equal in all treatments.

The calculation of the financial cost of sample A(100% beef) (1kg) which costs (27.688) SDP, and sample B (25% gizzard +75% beef) (1kg) costs (23.342) SDP, while the sample C (50% gizzard+50% beef) (1 kg) costs (18.995) SDP that reflects the lower price of chicken gizzard compare with prevalent market prices of sausage marketed to reveal the possible market value of the product.

Figure 4 **Recipe** cost of sausage treatments



A: Control (100%beef).

B: (25% chicken gizzards + 75%beef).

C: (50% chicken gizzards + 50%beef).

Table 4.4 Recipe cost of sausage treatments

No	Samples	Quantity /kg	Cost /Sdp
1	A	1.438	39.816
		1	27.688
2	B	1.438	33.566
		1	23.342
3	C	1.438	27.316
		1	18.995

S d p: Sudanese pound.

A: Control (100%beef).

B: (25% chicken gizzards + 75% beef).

C: (50% chicken gizzards + 50% beef).

Chapter Five

Conclusions and Recommendation

5.1 CONCLUSIONS

The study has concluded to the followings:

- Chicken gizzard sausages are nearly similar, in proximate analysis, physical properties and sensory evaluation to beef.

- Chicken gizzard sausage has good recipe and the low financial cost compared with beef, camel and chevon sausage.
- Excellent acceptability of new product.
- The flavor and aroma of chicken gizzard needs to improved with providing seasoning.
- The contamination level was generally higher in chicken gizzard-beef sausage in comparison with beef sausage.

5.2 RECOMMENDATIONS

This study has recommended to the following:

- To encourage the researchers to investigate other chicken meat alternatives for beef in sausage processing.
- Recommended continuation of the research in this issue.
- To explore more about chicken gizzard and other chicken by-products such as liver and heart.
- Chicken gizzards must be regarded as high quality meat in meat industry.
- Improve aroma and reduce toughness of chicken gizzards meat and improve processing technical and mixing ratios.

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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 checking at the point that best describes your
 feeling about the sample . If you any questions please ask . Thanks for your cooperation.

Name:

date:

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Sample code	color	Texture	Flavor	Juiciness	Comment
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BY :

Color	Texture	Flavor	Juiciness
8/Extremely desirable .	8/Extremely desirable .	8/Extremely desirable .	8/Extremely
7/ Very desirable .	7/ Very desirable .	7/ Very desirable .	7/ Very desir
6/Moderately desirable .	6/Moderately desirable .	6/Moderately desirable .	6/Moderately
5/ Slightly desirable .	5/ Slightly desirable .	5/ Slightly desirable .	5/ Slightly de
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