EFFECT OF DRYING ON NUTRITIONAL QUALITY OF DRIED MEAT (KILISHI)

BY

ADEYI ABDULRASAQ MASHOOD

2003/14768EA

AGRICULTURAL AND BIORESOURCES ENGINEERING DEPARTMENT FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE

NOVEMBER, 2008

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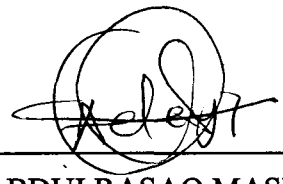
BEING A FINAL YEAR PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF BARCHELOR DEGREE OF ENGINEERING (B.ENG.) IN AGRICULTURAL AND BIORESOURCES ENGINEERING DEPARTMENT, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE

NOVEMBER, 2008

DECLARATION

I hereby declare that this project is a record of research work that was undertaken by ADEYI ABDULRASAQ MASHOOD. It has not been presented before for any degree or diploma or certificate at any university or institution. Information derived from personal communication published and unpublished works were dully referenced in the text.



ADEYI ABDULRASAQ MASHOOD

2003/14768EA

1/12/08

DATE

DEDICATION

This project work is dedicated to God almighty, His messenger prophet Muhammed (S.A.W.) and to m y beloved parent (Alhaji) Abdul-Rasaq Adeyi and (Alhaja) Abdul-Rasaq Iyabo Adeyi for their efforts to make me succeed in this project work and I pray, may God Almighty spares their life to witness more good things in life.

CERTIFICATION

This project entitled "that" Effect of drying on nutritional quality of dried meat (kilishi) by Adeyi Abdul-Rasaq Mashood, meets the regulations governing the award of the degree of Bachelor of Engineering (B. ENG.) of Federal University of Technology, Minna, and it is approved for its contribution to scientific knowledge and literacy presentation.

19/11/2008

Engr. Dr. (Mrs) Z.D. Osunde — DATE

Project supervisor

19/11/2008

Engr. Dr. (Mrs) Z.D. Osunde — DATE

Head of Department

External Examiner — DATE

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ABSTRACT

Kilishi is a dried meat product obtained from beef, goat meat, or lamb under hot and dry weather condition. 70g of fresh meat each from three different sources (cow meat, goat meat and sheep meat) was sun dried for complete twelve hours and their respective weight was weighed at the interval of one hour. The amount of moisture in wet base is 69.29%, 74.02% and 66.71% while the amount of moisture in dry base is 2.29%, 2.86% and 2.00% for cow meat, goat meat and sheep meat respectively. More so, the test and analysis were carried out on both fresh meat and dried meat product (kilishi) of the samples by using the standard procedure (AOAC). The obtained result shows the percentage moisture, ash, lipid (fat) crude protein, crude fibre and the amount of carbohydrate available in both fresh meat and dried meat product. From the result obtained for this research work it was observed that, drying has no negative effect on nutritional quality of dried meat product instead, it increases the nutritional quality of the dried meat product (kilishi) due to various ingredients added to it.

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CHAPTER ONE

1.1 INTRODUCTION

1.2 Back Ground of the Study

Efforts are increasing to support animal production in developing countries. However this is not matched by similar efforts to use preservation to overcome seasonal variation in meat supply. In addition the existing condition for slaughtering and meat handling in rural areas which cause quality deterioration and post harvest losses of meat must be improved. In fact there is lack of effort to provide knowledge and skill in adequate hygienic slaughtering, meat cutting and handling under rural condition. The absence of meat preservation techniques presents a serious constraint to the development of viable meat production (www.FAO.org).

Meat is highly perishable which has to undergo some form of preservation to avoid waste. The main method of meat preservation transferred by the medieval Arabic sources to west Africa was that of sun drying (Alonge and Hiko, 1981). There are many methods used to prepare dried meat. These include the exposure of strips of lean meat to the sun, as in the manufacture of pemmican by North American Idians, or a combination of salting followed by air drying, as in the preparation of chargui in South American and Bilton in South African (Lawrie, 1979). There are other methods of meat preservation which are; drying, freezing, curing and smoking, cold storage and chilling etc.

Meat drying under natural temperature, humidity and air circulation, including direct influence of sun-rays is the oldest method of meat preservation. It consists of a gradual dehydration of pieces of meat cut to a specific uniform shape that permits the equal and simultaneous drying of whole batches of meat. Also warm, dry air of a low

humidity of about 30 percent and relatively small temperature difference between day and night are optimal condition for meat drying. However meat drying can also be carried out with good results under less favourable circumstance when basic hygienic and technological rules are observed. The intensity and duration of the drying process depends on humidity, air temperature, and air circulation

. The reduction of the moisture content of the meat is achieved by evaporation of water from the peripheral zone of the meat to the surrounding air and the continues migration of water from the deeper meat layer to the peripheral zone. There is relatively high evaporation of water out of the meat during the first day of drying after which is decreases continuously. There will be weight loss of up to 60 to 70 percent when meat is being dried for three to four days; equivalent to the amount of water evaporation also continuous evaporation and weight losses during drying process causes changes in the shape of the meat through shrinkage of the muscles and connective tissue. The meat pieces become smaller, thinner and to some degree wrinkled. The consistency also changes from soft to firm and to hard. The dried meat product (kilishi) is obtained from sliced lean muscle of beef, goat meat or lamb and is made on a large scale under hot and dry weather condition prevailing from February to May. It is produced by sun drying thin slices of meat. However, recent experience indicates that kilishi can also be produced industrially by using tray-drying in a warm air oven. Also in the production of kilishi the connective tissue and adhering fats are trimmed off the meat and cut with a curved knife into thin slices of about 0.5cm thickness, 15cm length, and as much as 6cm width.

Meat drying is a complex process with many importance steps, starting from the slaughtering of the animal, carcass trimming, and selection of the raw material, proper

cutting and pretreatment of the pieces of the meat to be dried and proper arrangement of drying facilities. In addition the influence of unfavourable weather condition must also be considered to avoid quality problem or production losses. The correct meat drying lies in maintaining a balance between water evaporation on the meat surface and migration of water from the deeper layer to the meat (www. FAO. Org)

1.3 Objectives of the Study

The general objective of this work is to determine the effect of drying on nutritional quality of dried meat (kilishi)

- To evaluate the moisture loss of meat during drying
- To determine the nutritional contents of both raw and dried meat product
- To determine the proximate composition of both raw and dried meat product
- To determine the drying rate of meat.

1.4 Justification

- Kilishi is considered as a source of protein in a daily human nutrition .There fore it si very essential to know the effect of drying on nutritional quality of kilishi (dried meat).
- Ever since kilishi has been produced locally in West Africa precisely Nigeria, the drying rate to obtain the final dried meat product is not yet determined which is very necessary.

1.5 Scope of Study

There are various types of meat from which dried meat product can be obtained based on the species of the animal used. Therefore the scope of this work is to determine the effect of drying on nutritional quality of dried meat product "kilishi" processed from cow (beef), goat meat and sheep meat.

CHAPTER TWO

LITERATURE REVIEW

2.1 Meat and Meat Product

Meat is an excellent source of high quality B-complex vitamins and certain minerals especially iron. It digests easily when cooked and supplies nutrient which contributes significantly to the dietary balance of meal. Meat is the flesh of animals consumed for food. In the tropics the bulk of meat consumed is mostly derived from sheep, cattle, goat, pig bush meat, poultry, bird, domesticated animal or wild animal, reptile animal and other sea foods (Hendrickson, 1978).

2.2 Meat Inspection

The adequate inspection of meat is very essential. The principal reason for meat inspection is to protect consumers from Zoonotic diseases. It has also been introduced in order to condemn those carcass parts that are heavily contaminated or have undergone unfavourable biochemical changes and are therefore not suitable for further processing (FAO, 1994).

2.3 Selection of Meat for Drying

As a general rule only lean meat is suitable for drying. Visible fatty tissues adhering to muscle tissue have a detrimental effect on the quality of the final product. Under processing and storage conditions for dry meat, rancidity quickly develops, resulting in flavour deterioration. The meat best suited for drying is the meat of a medium aged animal. In good condition, but not fat. Meat from animals is less good nutritional

condition can also be used for drying, but the higher amount of connective tissue is likely to increase toughness. It is important that raw material for the manufacture of dry meat is examined carefully of undesirable alterations such as discoloration, hemorrhagic spots, of-oddours manifestation of parasites, etc such defects must be trimmed off.

2.4 Recommended Treatment Before Drying

Meat is always consumed slightly salted; the raw material may be pre-salted before drying. This is not only contributed to a taste of product, but also desirable from the technological and hygienic standpoint. Pure common salt is used for this purpose, either dry or dissolved in water. In case of meat for drying cut into strips or flat pieces, the use of a 14 percent salt solution is preferred. This treatment is done to inhibit micro biological growth on the meat surface (www.FAO. Org)

2.5 Techniques of Meat Preservation and Processing

Meat processed and preserved by drying are usually more readily available in the market than any other preserved form such as freezing and irradiation. Apart from its availability, dried meat product are consumed without further procession except if the consumer want it in soup mixes. It has been revealed from research that 100g of processed beef will supply the required amount of protein needed by body, that same quantity could contain about 200 calories of energy apart form the nutrients such as vitamins, minerals, fats, water and sugar (Garrard, 1971)

2.5.1 **Intermediate Moisture Meats.**

The evaporation of water or the replacement of part of the meat (which contains 80 percent water) with non-meat additives can often help to extend the shelf life of a product. The substitution of meat with plant products or expressed in scientific terms, the water activity in the product. The products microbiological stability increases when less water is present for microbiological growth. The technical term for food products with reduced water activity is intermediates moisture (IM) foods. All empirical meat preservation methods based on the drying of the meat or meat products fall into this category. Drying can either be done alone or in combination with other methods such as salting, curing or smoking. Meat drying techniques have been used of centuries and be considered the oldest meat preservations method (FAO, 1990; FAO, 1993)

The meat is cut into small pieces and treated with a mild salt solution, the humectants and an antimycotic (anti-mould agent) are added and the meat cooked to 70°c before packaging. It will be kept for several months even at 38°c but there are changes in texture, colour and flavour (Lawrie, 1991). The product preserved in this way are called intermediate moisture foods and they are more succulent than dried foods but the humectants spoil the palatability and the process has been limited to animal foods in industrialized communities and for military purposes.

2.5.2 **Heat Treated Product**

The new modern meat preservation techniques are playing an increasing important role in meat processing in developing countries. Heat treated product in hermetically sealed containers are one of these new technique. The best known of these

are canned meat products which are pasteurized or sterilized. The sterilized product can be stored under ambient temperature for up to three or four years. Also the micro-organism can be completely destroyed by heat (sterilization) but a sterile product can be readily decontaminated unless it is protected. This is achieved by heating in an air tight can or bottle, or more recently, in a heat resistant or aluminum foil laminated plastic pouch. Canning operations must be performed only by fully trained personnel (FAO, 1990C; Hershom and Hulland 1980)

2.6 Theory of Meat Drying

Drying of meat implies the removal of water from the meat. The micro-organisms cannot grow unless there is sufficient moisture available to them and drying meat under condition of natural temperatures and humidity with circulation of air and the assistance of sunshine is the oldest method of meat preservation (FAO, 1990c). Muscle meat of any kind can be dried but it is necessary to use lean meat since fat becomes rancid during the drying process. The meat is cut into long thin strips of flat thin pieces and preferably salted, either dry or by dipping into salt solution, to inhibit bacterial growth and to protect them from insects.

Meat drying is simply the exposure of strips or flat pieces of fresh meat to the sun or open air, this treatment reduces the meats waters content rapidly that no bacterial spoilage can take place, even though the temperature remain high. There are certain disadvantages with this simple drying method, however, including contamination by insects, dust and other environmental impacts. Cabinet solar dryers have been especially developed for this purpose, where warm air is conducted through a hermetically closed

chamber, thereby avoiding any undesirable impacts from the outside. So far no source of energy other than the sun has been used in solar drying method (FAO, 1993; FAO, 1994d).

2.6.1 Factors Affecting the Rate of Drying

The factors that affecting the rate of drying are:

i. The physical and chemical properties of the product such as shape, size, composition, moisture content.

ii. The geometrical arrangement of the product in relation to the heat transfer surface or medium (e.g tray loading)

iii. The physical properties of the drying environment such as; air temperature, humidity, velocity.

iv. The characteristics of the drying equipment; heat transfer.

It is generally observed that many food products undergo an initial rapid, constant rate drying period, followed by a lower, decreasing drying rate period, sometime at two different rates. Drying the constant rate period, moisture evaporation must diffuse from within the food. Thus removal of the final 15-20% of the total moisture removable during dehydration accounts for a large proportion of the time and energy for dehydration, and for some products limits, the quality of the dehydrated food obtained (Ihekoronye and Ngoddy, 1985).

2.6.2 Meat Drying in Combination with Additional Treatment

2.6.2.1 Cured Dried Meat

Curing is the impact of nitrite on meat, in particular on the muscle pigment, myoglobin, which result in the formation of the pigment myochromogen and gives a stable red colour to muscle tissue. In addition, nitrite inhibits to some extent microbiological growth in the meat, but does so efficiently only in combination with low temperatures and/or low water activity. These effects are of particular importance for shelf of raw hams and dry sausages and may also be of importance for non-intensively dried biltong, the South Africa dried meat, which may also be manufactured with nitrite or nitrate (www. FAO.org.).

2.6.2.2 Smoked Dried Meat

Smoking of meat is a technique in which meat is exposed directly to wood smoke which may be generated by a variety of methods. In smoke produced from wood there are various substances which contribute to the flavour and the appearance of the smoked meat product and which have a certain preserving effect on the product. However, the preserving effect of common smoking is not very significant when storing the product without a cold chain. On the other hand, intensive or prolonged smoking may considerably increase the shelf life of the product, but is also has no unfavourable effect on flavour. Whereas a light smoke aroma generally enhances the organoleptic properties of the product, intensive smoking has a negative influence on the quality especially in the case of prolonged storage in which concentrated smoke compounds develop increasingly unpleasantly flavours (www.FAO.org)

There are other methods by which dried meat can be produced. The traditional kilishi (dried meat) is prepared using quality beef. It is prepared by skill fully cutting lean meat into thin sheets (1-2mm thick). These sheets meat are sun dried on a raised wooden table covered in rush matting for about four hours. The sheets of meet are then immersed in slurry of ground nut caked and seasonings including sugar, salt and paper (Igene, 1988). After immersion the meat is returned to the rush matting to dry in the sun for a further five to twelve hours. The product is finally roasted briefly over fire. Also kilishi is prepared by partially drying thin sheets of quality beef n the sun followed by marinating in slurry of ingredients before a second period of sun drying and briefly roasting (Igene *et al.,* 1990)

2.7 Principles of Kilishi (Dried Meat) Processing

The meat is cut into thin slices, spiced and sun dried. The preservation is mainly due to the low moisture content but the spices also have an antimicrobial effect. The dried meet process involved many important steps such as cutting of meet into thin slice, trimming of adhering fats washing the meat with clean water, pre-treatment of the meat to be dried, sun drying, mixing with ingredients, and finally roasting on glowing fire. The stages involved in kilishi production from raw meat are shown in figure 2.1 below.

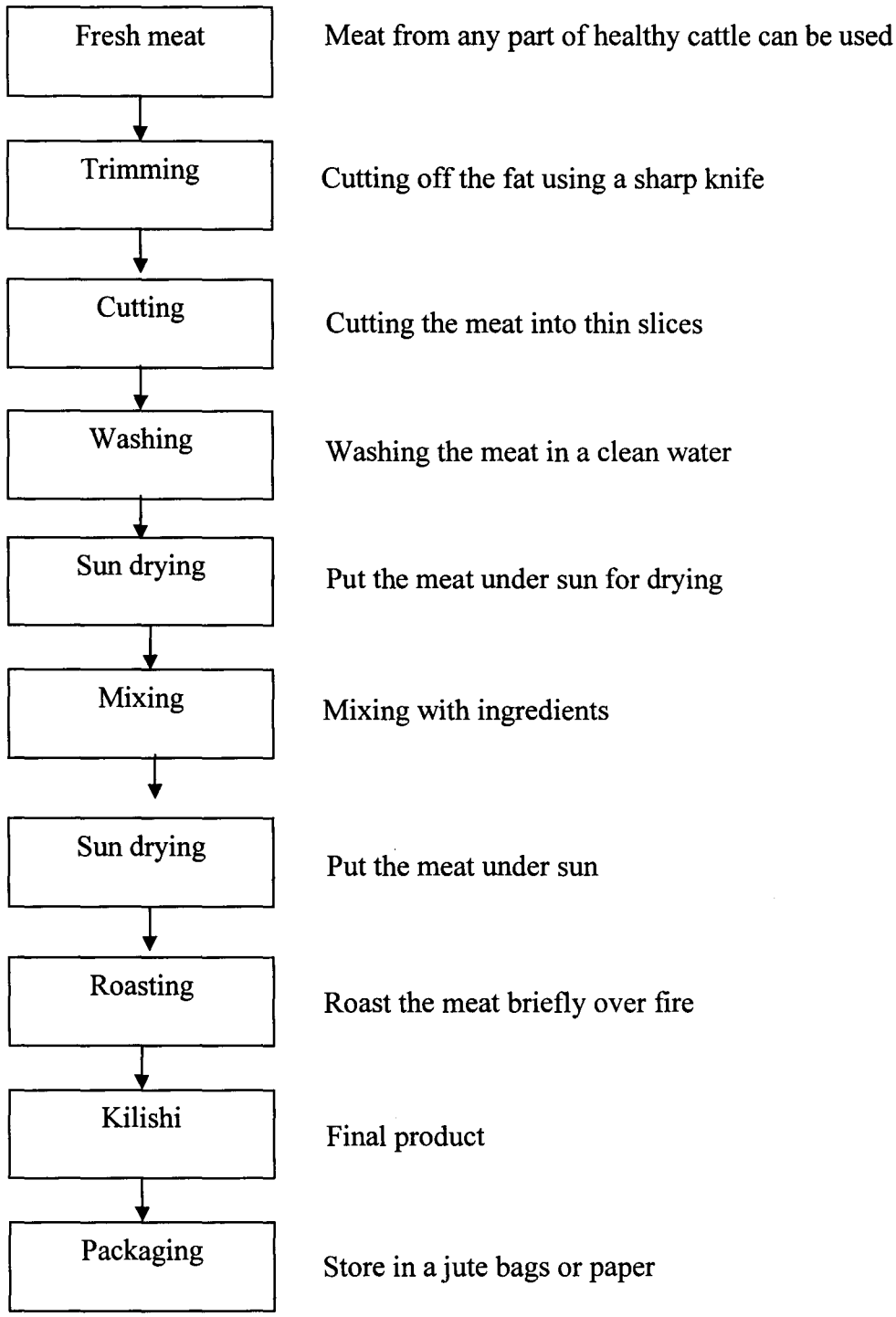

Fig. 2.1: the stages involved in the production of kilishi from raw meat sample

Source: (peter fellows, 1997)

2.7.1 Composition of the Mixture of Ingredients Used in the Production of kilishi (Dried Meat).

2.7.1.1 Mixing

Most processed food are mixtures of numerous ingredients. Some must be incorporated as uniformly as possible. Other such as smoke, may be highly localized in their placement in the product (Dennis *et al,* 1998) the composition of ingredients used in kilishi production are shown in table 2.1 below.

Table 2.1: **Composition of Ingredients Used in Kilishi Production**

Ingredient	weight (g)	proportion by weight mixture (g/kg)
Dried pepper	200	46.9
Alliums cepa	500	117.30
Groundnut	25	4.90
Zingiber officinate (Ginger)	100	25.1
Magi	6	1.40
Salt	80	18.80
Sugar	80	18.40
Water	1500	352

Source: (Ignene *et al.,* 1989)

2.7.2 Process control

The main quality control points are;

i. Thickness of the slices which determines both the drying time and texture of the final product. Pounding is an important stage because the is eaten by tearing pieces off the strip and it must there for be thin and soft.

ii. The spice mixture should be evenly distributed through al parts of the meat during the pounding stage(peter fellow,1997).

2.7.3 Typical Dried Meat Products with or without Additional Treatment

2.7.3.1 Odka (Somalia and other East African Countries)

Odka is basically a sun dried meat product made of lean beef and is of major importance to nomads in Somalia. The production of odka is similar to simple drying techniques of meat. However, the meat strips cut for drying are bigger and dry salting is usually applied instead of brine salting. After only four to six hours sun drying the large pieces pf meat are cut into smaller strips and cooked in oil. After this heat treatment drying is continued and finally sauces and spices are added. For storage odka is covered with oil and when kept in tightly closed container, it has a shelf life of more than twelve months (www.FAO.org).prior to the strips are coats with a sauce containing a mixture of salt (25 percent), hot pepper (50 percent) and aromatic seasoning (25 percent). After air drying, the meat spices may be further exposed to alight wood smoke and then fried in butter fat and dried again to some extent. At this stage the product is ready for consumption or storage (www. FAO.org).

2.7.3.2 Kilishi (Nigeria and other Arid or semi Arid zone of west Africa).

kilishi is product obtained from sliced lean muscles of beef, goat meat or lamb and is made on a large scale under the hot and dry weather conditions prevailing from February to May. It is produced by sun drying thin slices of meat.

However, recent experience indicates that kilishi can also be produced industrially using tray drying in a warm air oven. Connective tissues and adhering fats material are trimmed off the meat and then cut into thin slices of about 0.5cm thickness, 15cm length, as much as 6cm width.

In first stage of drying, which takes two to six hours the moisture of meat slices has to be reduced to about 40 to50 percent. The slices are then put into an infusion containing defatted wet ground nut cake past or soybean flour as the main component (about 50 percent), and further composed of water (30 percent),garlic (10 percent),salt (2 percent), and spices such as pepper, ginger, and onion. The dried slices of meat should absorb the infusion up to almost three times their weight.

After infusion, the wet product is again exposed to the sun todry. Drying at this stage is much faster than the first stage. When the moisture content of the slices has been reduced from 20 to 30 percent, a process which takes two to three hours depending on weather conditions and the dimensions of the product, the slices are finally roasted over a glowing fire for about five minutes. The roasting process help to enhance desirable flavour development and to in activate contaminating micro organisms. Roasted kilishi is therefore superior in flavour to the un roasted version. The moisture content ranges between 10 to12 percent after roasting. It will decrease during storage at room temperature to as low as 7 percent when packaged in hermetically sealed, low density plastic bags the product remain remarkably stable at room temperature for a period of about one year (www. FAO. org).

2.8 Nutritional Values of Meat

Meat and other animal foods such as milk, can make a valuable contribution to the diets in developing countries it has less nutritional importance in industrialized countries where a wide variety of food of all kinds is available. The importance of meat in the diets is as a concentrated source of protein which is not only of high biological value but its amino acid composition complements that of cereal and other vegetable proteins. it is also a god source of iron and zinc and several B vitamins, and liver is a very rich source of vitamin A the composition of lean muscle are shown in table 2.2 below.

Table 2.2: composition of lean muscle.

Components	Net Weight (%)
Water	74.0
Ash	2.0
Fat	2.0
Protein	20.0
Carbohydrate	2.0

(Norman Desrosier and James Derosier, 2004).

2.8.1 Moisture content

The structure of the muscle and its substructure especially the highly organized insoluble myotibillar protein are responsible for the retention of (about 75%) water in muscular tissue Water holding capacity or ability of meat depends on the method of handling and the state of the system. As the state of material and its treatment different considerably, the water holding capacity varies widely.

2.8.2 Ash content

These are inorganic compounds which appear in food analysis i.e. they are substances left behind when carbon, hydrogen, and nitrogen (organic compounds) has been burnt off by excess oxygen. In other words, ash of a biological material is an analytical term for the inorganic residue that remains after the organic has been burnt off. An adult may have over 1kg of calcium in his body, where as he has only 5 to 10 mg chromium and that of copper is 150mg (NRC,1996).

2.8.3 Lipid Content

The lipid contents of biological materials are group of substances found in plant and animal tissues, insoluble in water but soluble in common organic solvent such as benzene ether, petroleum ether and chloroform. the group includes the fat and a number of closely related compounds (NRC,1996). However the chemical composition of food is usually described in terms of its percentage nutritional composition. The percentage composition of lean muscle is 2.0% (Norman Derosier and James Derosier,2004).

2.8.4 Protein Content

The chemical composition of food is usually described in terms of its percentage nutritional composition. Animal tissues are usually rich source of protein. The percentage composition of protein in lean muscle is 20%(Norman Derosier and James Derosier,2004). The quality of protein is a measure of its ability to satisfy human requirements for the amino acid. All proteins both dietary and tissue proteins, consist of

two groups of amino acids, those that must be indigested ready made i.e. are essential in the diet, and those that can be synthesized in the body in adequate amounts from the essential amino acids. Eight of the 20 food amino acids are essential for adults and ten for children. The quality of dietary protein can be measured in various ways (FAD/WHO, 1991) but basically it is the ratio of the available amino acids in the food or diet compared with needs. The Composition of different cuts of meat are shown in table 2.3 below.

Table 2.3: Composition of different cuts of meat

	Cut of meat	Protein (%)	Moisture (%)	Fat (%)	Ash (%)	Cal/100g
BEEF	Chuck	18.6	65	16	0.9	220
	Topside	19.5	69	11	1.0	180
	Rumb	16.2	55	28	0.8	320
LAMB	Breast	12.8	48	3.7	0.7	380
	Leg	18.0	64	18	0.9	240
	Lion	18.6	65	16	0.7	220
	Rib	14.9	52	32	0.8	360
	Shoulder	15.6	58	25	0.8	300

(Sawyer, 1975).

2.8.5 Fiber Content

Crude fibre is a chemical entity. It is the remnant after food material or more precisely meat, has been treated with concentrated H_2SO_4 and alkali in other words, crude fibre is a measure of the effectiveness with which raw materials have been milled or processed (Dennis *et al.*, 1998)

2.8.6 Carbohydrates

These are group of compounds that contain the elements of carbon, hydrogen and oxygen. Carbohydrates are found in food either a sugar or as starch and glycogen. These later material are long straight or branched chain of the many sugar molecules joined together. The chemical natural of sugars determines their properties, their functions in living tissues and how starches are formed and broken down (watt and merill, 1975)

2.9 Quality of the Finished Product

The dried meat that is ready for consumption and which can be packaged, stored or transported should meet the following quality criteria.

- The appearance of the dried meat should be as uniform as possible. The absence of large wrinkles and notches indicates the desired steady and uniform dehydration of meat.
- The colour of the surface, as well as of the cross-cut, should be uniform and dark red. A darker peripheral layer and bright red colour in the center indicates incorrect, too fast drying with the formation of hard rind which hinders evaporation from the deeper layers of the product. In this case the central parts have a brighter colour and softer

consistency and are, because of the higher water content, more susceptible to microbiological spoilage. When packaged or other wise stored.

- Taste and flavour are very important criteria for the acceptance of dried meat by the consumer. . Dired meat should posses and mild salty taste which is characteristics for naturally dried meat with no added spices. Off odours must not occur. However, a slightly rancid flavour which because of chemical changes during drying and storage is commonly found in dried meat (www. FAO. Org)

2.9.1 Packaging and Storage

Packaging serves to protect the product from contamination to which the meat might be exposed on its way from the producer to the consumer. Numerous materials are used for packaging dry meat, such as paper, plastic foils, aluminum foils, cellophone and textiles. The longest shelf life is obtained using vaccum-packagin. Transparent plastic material and cellophone are more appealing to the consumer.

During storage special cak has to be taken to prevent dried meat, which is not packaged in water proof containers, form becoming wet, resulting in rapid growth bacterial and moulds. For this reason the premises for storing dried meat have to be rain-proof. It is good to cover the piles of packaged dry meat with plastic sheets, as additional protection against moisture and dust.

CHAPTER THREE

3.1 Material and Method

3.2 Raw Materials and their sources

Two hundred grams each of raw meat from three different sources, cow meat (beef), goat meat, and sheep meat were bought at Bosso Market Minna, Niger State. Each of the raw meat was kept inside the polyethylene bags labeled A, B and C respectively under ambient temperature. These samples were taking to the Federal University of Technology Bosso Campus Minna. 140g of each sample was processed into kilishi (see figure 2.1) and their respective drying rate was determined by checking their weight using an electronic weighing balance at the interval of one hour. The product "kilishi" was allowed to cool before package into another three set of polyethylene bags labeled D, E and F respectively. The remaining 60g each of the raw meat samples inside the polyethylene bags labeled A, B and C were taken to Biochemistry laboratory FUT, Minna, for nutritional test and analysis together with the product of the sample inside the polyethylene bag D, E and F.

3.3 Reagents and Instruments

3.3.1 Reagents

Tetraoxosulphate (iv) acid (H_2SO_4), Sodium hydroxide (NaoH), Calcium chloride ($cacl_2$), calcium hydroxide ($Ca(OH)_2$), methyl orange indicator, ammonium chloride solution (NH_4CL), petroleum ether, copper sulphate ($CUSO_4$)

3.3.2 Instrument/Apparatus

Crucible

Muffle furnace

Filter paper

Water bath

Petridishes

Desiccators, weighing balance (with sensitivity of 300g)

Electronic weighing balance (with sensitivity of 200g), Bunsen burner

Oven (gallen kamp oven 3,000 plus-series), soxhlet extractor, flat bottom silica dishes, pipette and conical flask.

Muffle furnace

Thimble

Soxlet extractor

Kjeldah flask

Electric heater and crucible

3.4 Proximate Analyses of Meat and Meat Product

The proximate compositions of these samples were determined using the method as given by Association of Analytical Chemist Standard Procedure (A.OA.C, 1980) and micro kjeldah nitrogen method.

3.431 Determination of Moisture Content (%)

A metallic dish was dried in an oven at 80°C for 20 minutes, it was cooled in a desiccators and weighed (W_1)g. 2g of sample A was put into the dish and weighed (W_2)g. the dish with the sample A was dried in an oven at 80°C for 24 hours until the constant weight was reached, it was then quickly transferred into a desiccators to cool. It was weighed quickly with minimum exposure to atmosphere (W_3)g. the loss in weight of the sample A during drying is the moisture content. This procedure was repeated for sample B, C, D, E, and F, respectively. It was calculated as follow;

Weight of empty metallic dish = W_1 (g)

Weight of metallic dish + fresh sample = W_2 (g)

Weight of metallic dish + dry sample = W_3 (g)

Weight of fresh sample = (w_2-w_1) (g)

Weight of dry sample = (w_3-w_1) (g)

$$(\%) \text{ moisture content } = \frac{(w_2-w_3)}{(w_2-w_1)} \text{ X } 100$$

3.4.2 Determination of Ash Content (%)

The ash of a biological material is analytical term for the inorganic residue that remains after the organic matter has been burnt away.

A clean, flat bottomed silica dish (about 7 cm in diameter was hold in a hot bursen-burner flame for one minute, it was then transfer into a desiccators to cool and weighted (W_1) 2g of sample A was put into the dish and weighed (W_2). The silica dish contained the sample a was heated gently, on a bursen-burner in a fume cupboard until

smoking cease, it was then transfer to a muffle furnace heated to about 500°C. the heating was continued until all the carbon burnt away for about 24 hours. The furnace was switched off, the silica dish was taking out, then covered immediately and placed inside a desiccators to cool and weighed (W_3). This procedure was repeated for sample B, C, D, E, and F respectively.

$$(\%) \text{ Ash content} = \frac{(W_3-W_1)}{(W_2-W_1)} X\ 100$$

The portion of the samples, which burnt off was organic matter. It was calculated as;

$$(\%) \quad \text{Organic matter} = \frac{(W_2-W_3)}{(W_2-W_1)} X\ 100$$

3.4.3 Determination of Lipid Content (%)

The lipid content of a biological material can be estimated by directly extraction of the dry material exhaustively using a suitable lipid solvent e.g petroleum (40°C-60°C) diethyl ether etc. in a convenient continues extractor, such as soxhlet, Bolton or Bailey Walker type. Direct extraction gives the proportion of free fat.

2g of the sample A in powdered form was taken into a thimble of known weight (W_1). Both the sample A and thimble was weighted (W_2) the thimble with sample A was placed inside a soxhlet extractor. 30cm^3 of ecetone-ethanol mixture of (1:1) was put into a 500ml round bottom ground joint flask, which was silted in electrically connected heating mentle, the mentle was switched on the heat increased carefully and slowly until the solvent boiled. (Condensed solvent with dissolved lipid was continuously rush back into the flask). The heating and the extraction process was continued for about 24 hours,

then cooled in a desiccators and weighed (W_3). This procedure was repeated for sample B, C, D, E and F. respectively.

(%) lipid content $= \frac{(W_2-W_3)}{(W_2-W_1)} X\ 100$

The solvent was distilled off to about 20ml, the lipid in solvent solution was quantitatively transferred on to an evaporating dish, cooled, dried in desiccators the lipid thus recovered may be weighed and (%) lipid calculated.

3.4.4 Determination of Nitrogen and Crude Protein (%)

The reference micro kjeldi protein determines the total nitrogenous matter which includes non protein as well. Most proteins contain about 16% nitrogen. Total nitrogen, estimated by the kjeldah method is multiplied by 6.25 to express the average crude protein. Kjeldah method is a volumetric method producing $(NH_4)_2S_4$ by acids digestion of sample. From alkaline digest, ammonia is distilled off, collected a boric acid complex and estimated.

Procedure:

a. 0.25g of sample A was weighed accurately into a clean, dry 100ml kjeldan flask. One gram mixed catalyst, 6ml conc. H_2SO_4 and few chips of pumice stone or few glass bids were added to it.

b. This was carefully digested over an electric heater in the hood initially with low flame frothing subsided and then at higher temperature until contents were cleared greenish, the digestion was continued for further 60 minutes.

c. The heater was put off the flask was allowed to cool and 15ml of water was added, the contents was then transferred quantitatively into a 50ml volumetric flask using distilled water to rinse out, but leaving the pumice stone behind. 5cm^3 of distilled water was made and mixed very well.

d. 10ml of the digest was pipette and transferred into semi micro nitrogen still, 10ml of 40% Sodium hydroxide solution was added to the digest. The steam distills ammonia librates into the 5ml boric acid solution that contained four drops of mixed indicator taken in the conical flask. The indicator turned green and then distillation was continued for 2 minutes.

e. The distillates was removed and titrate with the standard hydrochloric acid, the end point was reached when the indicator changed from green through grey to definite pink. The amount of acid consumed was recorded. This procedure was repeated for sample B, C, D, E, and F respectively.

(%) nitrogen in the sample $= \frac{corrected\ titre\ (ml) \times 14 \times 5 \times 100}{1000 \times 70 \times sample\ weight\ (g)}$

$= \frac{Corrected\ titre\ (ml}{10 \times sample\ weight\ (g)}$

So Crude Protein Content (%) = 6.25 x nitrogen (%)

3.4.5 Determination of Crude Fibre (%)

The crude fibre was determined in accordance with the method described by (A.O.A.C, 1980). 2g of sample A was taken and defatted with petroleum ether for 8hrs it was boiled under reflux for exactly 30 minutes with 200cm^3 of 1.25% H_2SO_4. It was filtered and washed with boiled water until the washing were no longer acidic. The residue was boiled in a round bottom flask with 200cm^3 of 1.25% NaoH for another 30

minutes and the crucible with sample (residue) was dried in the oven at 100°C. It was left in a desiccators to cool and weighed (C_2). It was then incinerated in a muffle furnace at about 600°C for 3hours. This was then put in a desiccators to cool and weighed (C_3). This procedure was repeated for sample B, C, D, E, and F respectively.

Calculation

Weight of fibre = $C_2 - C_3$

$$(\%)\ \text{fibre} = \frac{C_2 - C_3}{\textit{Weight of original sample}} \times \frac{100}{1}$$

3.4.6 Determination of Carbohydrate (%)

Carbohydrate values are obtained by subtracting the total percentage of water, mineral, protein and fat form hundred. This is known as carbohydrate by difference and is used because no satisfactory method exists for determining carbohydrate by direct analysis (Helen Andrews Guthrie, 1979).

This method was used to determine the percentage carbohydrate of Sample A, B, C, D, E and F respectively

Calculation.

(%) carbohydrate = 100 – (P+L+M+MC)%

P = (%) Protein

L = (%) lipid (fat)

M = (%) mineral

Mc = (%) moisture content

CHAPTER FOUR

4.1 RESULTS AND DISCUSSION

4.2 Results

The obtained results for this project are presented in table 4.1 and 4.2 below.

Table 4.1: Average value of the drying rate of meat

Time (hr)	Wt of samples (g)	Wt of samples (g)	Wt of samples (g)
	A	B	C`
0	70.00	70.00	70.00
1	61.88	49.63	63.77
2	53.89	43.09	56.63
3	49.85	39.39	51.97
4	43.81	36.24	47.08
5	40.09	34.27	43.49
6	37.09	33.38	40.49
7	36.67	33.10	40.12
8	35.48	32.72	39.73
9	34.07	31.24	37.41
10	30.26	30.84	33.90
11	28.04	29.56	29.95
12	21.45	18.15	23.30

Sample A = Cow meat

Sample B = Goat meat

Sample C = Sheep meat

Table 4.2: The Average value of the nutritional content of fresh meat (cow meat, goat meat, sheep meat) and their respective dried meat products (kilishi).

Meat Source	Moisture content (%)		Ash content (%)		Lipid content (%)		Crude protein (%)		Crude fibre (%)		Carbohydrate (%)	
	FM	K	FM	K	FM	K	FM	K	FM	K	FM	K
Cow	69.00	11.00	1.00	9.50	11.00	19.67	19.50	38.99	4.17	4.83	-0.50	20.85
Goat	74.00	11.83	0.50	5.17	10.33	17.00	15.05	37.22	2.33	2.83	0.36	28.78
Sheep	65.00	9.33	0.67	16.00	16.00	22.00	18.60	38.68	2.67	2.83	-0.27	23.82

4.3 Discussion of Result

The Table 4.1 shows that, at the initial stage of drying, the rate at which water evaporated from the meat was very high which decreases continuously until the constant weight was obtained. There was loss in weight of about 69.29%, 74.02%, and 66.71% for cow meat (beef), goat meat, and sheep meat respectively which is equivalent to the amount of water evaporated. The amount of moisture in wet base (Wb) was found to the same as the percentage weight loss above, while the amount of moisture in dry base (Wd) was found to be 2.29%, 2.86%, and 2.00% for cow meat (beef) goat meat and sheep meat respectively.

However, it is generally observed that many food products such as meat undergo an initial rapid constant rate of drying period follow by a slower, decreasing drying rate period (Ihekoronye and Ngoddy, 1985).

Therefore, the average weight of the meat sample A,B,C (Cow meat, Goat Meat and Sheep meat) are plotted against the drying period in the Figure 4.1 below

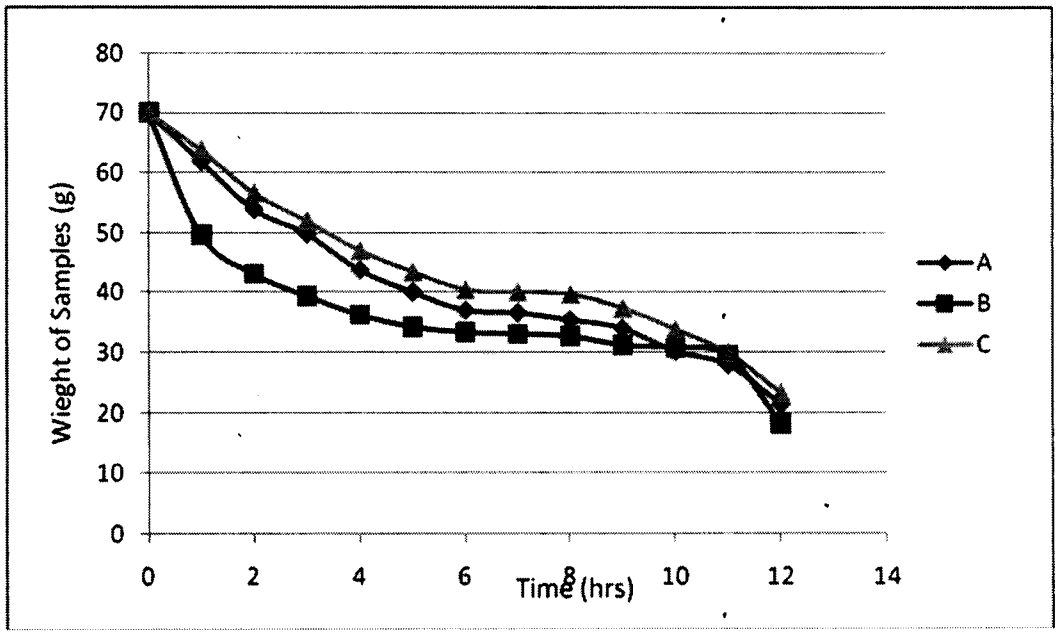

Fig 4.1: Average Weight (g) of the Sample against Time (hr)

From the figure 4.1 it was observed that, as the drying period increase, the weight of the samples decrease. Also it was observed that, the weight loss in sample B (Goat Meat) was high compared to sample A (Beef) and sample C (Sheep meat). This implies that, there is high loss of moisture in goat meat than both cow meat and sheep meat.

From table 4.2 it was observed that there is reduction in moisture content of fresh meat to dried meat product (kilishi) from 69.00% to 11.00%, 74.00% to 11.83%, 65.00% to 9.35% for cow meat, goat meat and sheep meat respectively. However, the obtained value of moisture content for beef and sheep meat or lamb are in line with the reported values in table 2.3 in the literature review, while that of goat meat is in line when compared with the value in table 2.2 in the literature review. Therefore, the reduction in moisture content of both fresh meat and dried meat product (kilishi) is not only prolong the shelf – life but also increase the concentration of nutritional values of dried meat production (kilishi).

Table 4.2 indicates that the Ash content of the meat increased during drying. The increase was from 1.00%, 9.5%, 0.50%, to 5.17%, 0.67% to 6.17% for cow meat, goat and sheep meat respectively. The obtained value of ash content for cow meat (beef) is in agreement with the reported values in the site reference while that of sheep meat or lamb was reduced by 0.03% when compared with the values obtained by (Sawyer, 1975). This reduction in ash content of sheep meat or lamb may be due to the feed taken by the animal, the age of the animal and the environmental condition where it grown. However, increase in ash content of fresh meat to dried meat product (kilishi) is due to the amount of ingredient added to it which in turn increases the flavour of the dried meat products.

From table 4.2, it was also observed that there is an increase in liquid (fat) content of fresh meat to dried meat product (kilishi) from 11.00% to 19.67%, 10.33% to 17.00%, 16.00% to 22.00% for cow meat (beef), goat meat, and sheep meat or lamb respectively. In this research work, the amount of lipid (Fat) content of both cow meat (beef) and sheep meat or lamb are in line with the values in the site reference. However, percentage increase in lipid (Fat) content of dried meat product makes it to have high energy value in human nutrition and also increase its flavour.

Table 4.2 indicates that there is an increase in percentage crude protein of fresh meat to dried meat product (kilishi) from 19.50% to 38.99%, 15.05% to 37.22%, 18.60%

to 38.68% for cow meat (beef), goat meat and sheep meat or lamb respectively. The obtained value of crude protein for beef and sheep meat or lamb in this research work is in agreement with value obtained by (Sawyer, 1975). However, the protein requirement of an individual is defined as the lowest level of protein intake that will balance the loss of nitrogen from the body of a person maintaining energy balance at modest level of physical activities (FAD/ WHO, 1985).

More so, Table 4.2 shows that, there is slight increase in percentage crude fibre of fresh meat to dried meat product (kilishi) from 4.17% to 4.83%, 2.33% to 2.83%, 2.67% to 2.83% for cow meat (beef), goat meat and sheep meat or lamb respectively. The slight increase in percentage crude fibre of fresh meat to dried meat product indicates that, the quantity of indigestible matter in the dried meat product(kilishi) is not much due to the high digestibility of protein by reducing the moisture content of the meat and subjecting it to a moderate roasting on a glowing fire after drying.

From the result obtained for this research work in Table 4.2, it was observed that, the amount of carbohydrate of fresh meat to dried meat product (kilishi) increased from -0.50% to 20.85%, 0.36% to 28.78%, -0.28% to 23.82% for cow meat (beef) goat meat and sheep meat or lamb respectively. However, increase in amount of carbohydrate of fresh meat to dried meat product is due to the various ingredients such as pepper, ginger, groundnut, onion, magi, salt e.t.c added to it which also makes it to have high energy value in human nutrition and also increase the palatability of the dried meat product (kilishi).

CHAPTER FIVE

5.1 CONCLUSION AND RECOMMENDATION

5.2 CONCLUSION

From the result obtained in table 4.1 for this research work, it can be seen that, as the drying period increases the weight of the samples decreases. This decrease in weight leads to some physical changes such as shape, colour, size, and the texture of the meat. However, continuous drying process makes the meat to become smaller, thinner and to some extent hard. Therefore, the rate of drying is dependents on the drying period, the temperature, and the air circulation.

From the result obtained in table 4.2 for this research work, it is very obvious that, the nutritional quality of fresh meat is not affected negatively by drying when processed into dried meat product (kilishi). Instead, it increases the concentration of nutritional value by reducing the moisture content to stop the microbiological activities that can takes place at high moisture content and also prolong the self-life of the meat. All the spices and ingredients added to it such as ginger, groundnut, pepper, magi, onion, salt etc increase the palatability, mineral content, protein content, fat content, amount of carbohydrate and also stabilized the colour of the dried meat product (kilishi).

However, it can be seen from the results that fresh meat is a poor source of carbohydrate. Then there are some variation in nutritional contents of each sample of meat (cow meat, goat meat, sheep meat), these variation may be due to feeds taken by the animal, the breed, age, sex, and environmental location where all these animals are grown up. Therefore, drying has no negative effect on the nutritional quality of the dried meat product (kilishi), instead it increases it.

5.3 Recommendation

(1) Drying of meat under the sun may either be over or under dried due to inability to control the intensity of the sun. Therefore, modern method of drying such as oven drying method which will save more time and also provides the access to regulate the temperature and the hotness using the temperature regulator and thermostat of oven should be adopted.

(2) It is not only in the dry season period that, the maximum production of dried meat product could be obtained. However, continous production of dried meat product (kilishi) can also be obtained throughout the year by adopting the advanced method of drying such as; tray drying.

(3) For further work, the percentage proximate composition of each ingredients used in dried meat product such as ginger, groundnut etc should be analyzed in order to ascertain the amount of nutritional value contains in each ingredients before adding it to dried meat product (kilishi)

(4) Roasting of the dried meat product (kilishi) should be done under low and moderate heat because over heating may affect the amino acid which in turn affect the protein content of the dried meat product (kilishi).

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APPENDICES

APPENDIX A

The values of the drying rate of meat

Sample A = Cow meat

Sample B = Goat meat

Sample C = Sheep meat

Table A1: Weight of Sample A (g)

Time (hr)	A_1	A_2	$A_1 + A_2$	$A = (A_1+A_2)/2$
0	70.00	70.00	140.00	70.00
1	61.89	61.87	123.76	61.88
2	53.93	53.85	107.78	53.89
3	49.80	49.90	99.70	49.85
4	43.81	43.81	87.62	43.81
5	40.10	40.08	80.18	40.09
6	37.11	37.07	74.18	37.09
7	36.68	36.66	73.34	36.67
8	35.49	35.47	70.96	35.48
9	34.08	34.06	68.14	34.07
10	30.27	30.25	60.52	30.26
11	28.05	28.03	56.08	28.04
12	21.46	21.55	43.00	21.50

Percentage moisture in wet base (W_b) = $\frac{W_1 - W_2 \times 100}{W_1}$

W_1=Weight of sample before drying (g)

Percentage moisture in wet base $(W_b) = \frac{W_1 - W_2}{W_1} \times 100$

W_1=Weight of sample before drying (g)

W_2=Weight of sample after drying (g)

% moisture in wet base $= 70 - \frac{21.50 \times 100}{70} = 69.29\%$

Percentage moisture in dried base (W_d) = MC/ (100-MC)

MC=69.29%

% moisture in dried base (W_d) =69.29/(100-69.29) =2.29%

Table A2: Weight of Sample B (g)

Time (hr)	B_1	B_2	$B_1 + B_2$	$B = (B_1+B_2)/2$
0	70.00	70.00	140.00	70.00
1	49.63	49.63	99.26	49.63
2	43.08	43.10	86.18	43.09
3	39.40	39.38	78.78	39.39
4	36.23	36.25	72.48	36.24
5	34.26	34.28	68.54	34.27
6	33.40	33.36	66.76	33.38
7	33.05	33.15	66.20	33.10
8	32.71	32.73	65.44	32.72
9	31.2 3	31.25	62.48	31.24
10	30.83	30.85	61.68	30.84
11	29.55	29.57	59.12	29.56
12	18.16	18.14	36.30	18.15

W_2=Weight of sample after drying (g)

% moisture in wet base = $70 - \frac{18.15 \times 100}{70} = 74.07\%$

Percentage moisture in dried base (W_d) = MC/ (100-MC)

MC=74.07%

% Moisture in dried base (W_d) =74.07/ (100-74.07) =2.86%

Table A3: Weight of Sample C (g)

Time (hr)	C_1	C_2	$C_1 + C_2$	$C = (C_1 + C_2)/2$
0	70.00	70.00	140.00	70.00
1	63.76	63.78	127.54	63.77
2	56.62	56.64	113.26	56.63
3	51.96	51.98	103.94	51.97
4	47.07	47.09	94.16	47.08
5	43.51	43.47	86.98	43.49
6	40.51	40.47	80.98	40.49
7	40.10	40.14	80.24	40.12
8	39.71	39.75	79.46	39.73
9	37.40	37.42	74.82	37.41
10	33.89	33.91	67.80	33.90
11	29.94	29.96	59.90	29.95
12	23.29	23.31	46.60	23.30

APPENDIX B

The nutritional contents of fresh Meat (cow meat, goat meat and sheep meat) and their respective dried meat product (Kilishi)

Table B1: Determination of Moisture content (%)

Meat Source	Weight of empty crucible W_1 (g)		Weight of crucible + Sample before Drying W_2 (g)		Weight of crucible + Sample after Drying W_3 (g)		% moisture content $\frac{W_2 - W_3}{W_2 - W_1} \times 100$		% average of moisture content	
	FM	K	FM	K	FM	K	FM	K	FM	K
Cow	15.64	23.20	17.64	25.20	16.26	24.97	69.00	11.50	69.00	11.00
	17.70	18.15	19.70	20.15	18.32	19.93	69.00	11.00		
	20.10	20.03	22.10	22.03	20.72	21.82	69.00	10.50		
Goat	13.95	17.39	15.95	19.39	14.47	19.15	74.00	12.00	74.00	11.83
	15.24	18.22	17.24	22.22	15.76	21.98	74.00	12.00		
	17.18	15.91	19.18	17.91	17.72	17.68	74.00	11.50		
Sheep	22.01	15.75	24.01	17.75	22.20	17.57	65.57	9.00	65.00	9.33
	21.10	16.17	23.10	18.17	21.80	17.99	65.00	9.00		
	19.07	16.04	21.07	18.04	19.79	17.84	64.50	10.00		

FM = Fresh Meat
K = Kilishi

Table B2: Determination of Ash Content (%)

Meat Source	Weight of empty crucible W_1 (g)		Weight of crucible + Sample before Ashing W_2 (g)		Weight of crucible + Sample after Ashing W_3 (g)		% Ash content $\frac{W_3 - W_1}{W_2 - W_1} \times 100$		% average of Ash content	
	FM	K	FM	K	FM	K	FM	K	FM	K
Cow	12.62	12.11	14.62	14.11	12.64	12.30	1.00	9.50	1.00	9.50
	17.10	13.06	19.10	15.06	17.12	13.25	1.00	9.50		
	12.15	14.11	14.15	16.11	12.17	14.30	1.00	9.50		
Goat	10.57	16.22	12.57	18.23	10.58	16.34	0.50	5.50	0.50	5.17
	13.24	18.22	17.24	22.22	15.76	21.98	74.00	12.00		
	17.01	10.26	19.01	12.26	17.02	10.36	0.50	5.00		
Sheep	9.97	11.22	11.97	13.22	9.99	11.34	1.00	6.00	0.67	6.17
	10.22	16.02	12.22	18.02	10.23	16.15	0.50	6.50		
	13.14	15.13	15.14	17.13	13.15	15.25	0.50	6.00		

FM=Fresh Meat

K=Kilishi

Table B3: Determination of Lipid (Fat) content (%)

Meat Source	Weight of thimble W_1 (g)		Weight of thimble + Sample before Extraction W_2 (g)		Weight of crucible + Sample Extraction W_3 (g)		% Lipid content $\frac{W_2 - W_3}{W_2 - W_1} \times 100$		% average of Lipid content	
	FM	K	FM	K	FM	K	FM	K	FM	K
Cow	1.44	1.57	3.44	3.57	3.22	3.18	11.07	19.50	11.00	19.67
	1.47	1.56	3.47	3.56	3.24	3.16	11.50	20.00		
	1.52	1.57	3.52	3.57	3.31	3.18	10.50	19.50		
Goat	1.48	1.57	3.48	3.57	3.30	3.24	9.00	16.50	10.33	17.00
	1.50	1.55	3.50	3.55	3.27	3.20	11.50	17.50		
	1.52	1.53	3.52	3.53	3.31	3.19	10.50	17.00		
Sheep	1.58	1.57	3.58	3.57	3.26	3.11	16.00	23.00	16.00	22.00
	1.57	1.55	3.57	3.55	3.24	3.12	16.50	21.50		
	1.59	1.54	3.59	3.54	3.28	3.11	15.50	21.50		

FM = Fresh Meat
K = Kilishi

V_1 = Blank = 0.1

M = weight of sample(g)

6.25 = constant value

Table B5: Determination of Crude Fibre

Meat source	Weight of sample (g) M		Weight of empty crucible W1(g)		Weight of crucible + dried residue W2(g)		Weight of crucible + ash residue W3(g)		% fiber content W2-W3*100/M		% average of crude fiber	
	FM	K	FM	K	FM	K	FM	K	FM	K	FM	K
Cow	2.00	2.00	12.03	9.98	13.45	11.66	13.37	11.56	4.00	5.00	4.17	4.83
	2.00	2.00	13.07	10.22	14.49	12.08	14.41	11.99	4.00	4.50		
	2.00	2.00	9.86	10.61	11.26	12.47	11.17	12.37	4.50	5.00		
Goat	2.00	2.00	10.62	10.21	12.12	12.03	12.07	11.97	2.50	3.00	2.33	2.83
	2.00	2.00	11.13	11.09	12.58	12.91	12.53	12.56	2.50	2.50		
	2.00	2.00	13.06	11.24	14.56	13.07	14.52	13.01	2.00	3.00		
Sheep	2.00	2.00	12.06	13.02	13.46	14.02	13.40	13.97	3.00	2.50	2.67	2.83
	2.00	2.00	13.17	11.12	14.58	12.92	14.53	12.86	2.50	3.00		
	2.00	2.00	14.01	9.98	15.41	11.79	15.36	11.73	2.50	2.50		

FM =Fresh Meat
K kilishi