DETERMINATION OF SALT AND MOISTURE CONTENT IN MEAT CURING

A research paper submitted to the faculty of

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Science Research II

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ABSTRACT

A lot of people nowadays who are into local curing business does not take into consideration the consistency of their method of meat preservation.

This study focuses only on the storage life of cured meat. Moisture and salt content are the two factors responsible for this. Lowering the moisture content leaves an environment in beef not suitable for bacterial growth and introduction of salt in meat also stops bacterial growth by providing turgidity to the meat. This study aims to determine the exact moisture content and salt content the beef meat needs in order to sustain an optimum storage life.

After performing the experiments the researchers noticed that in determining moisture content of meat, after about 5 hrs or 300 min of heating the meat in the oven, the rate of mass decrease was zero. In curing and testing for effectiveness of curing meat, the researchers found out that samples dried with 10% moisture content at 15% salt dilution has the lowest number of bacterial colonies after 2 days.

Therefore, the researchers concluded that cured meat having a moisture content of 10% and injected with 15% solution of brine is the most effective combination in meat curing.

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APPROVAL SHEET

This research paper entitled, "Determination of Salt and moisture Content in Meat Curing", submitted by Juline Ross Yandog and Aimee Esther Vicedo, in partial fulfillment of the requirements in Science Research II, has been examined and recommended for acceptance and approval.

April 1, 1998
Date

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This research paper is accepted and approved in partial fulfillment of the requirements in Science Research II.

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INTRODUCTION

A. Rationale of the Study

There are many reasons why meat needs to be processed. Processing meat prolongs its storage life, enables the utilization of the otherwise waste by-products into delicious food, increases the variety of preparations, improves the quality and therefore, add value to the processed products.

In the Philippines, most of the livestock are produced in the rural areas. Yet meat and meat products are not easily available in these places. If meat processing can be done in the countryside, this could significantly improve the profitability of the smallholder raisers and the productivity of the communities (Villareal, 1989).

Filipinos have that preference for home-made or what they call " lutong bahay" foods. Although this may be a reflection of close family ties and highly family oriented values, "lutong bahay" foods always carry with them the connotative meaning of delicious, natural tasting yet cheaper quality foods.

Such case is very true with meats. Inspite of the numerous processed and canned meat products we now have in the market, Filipino families may still opt for home-made

processed meat. This is not only because of the connotative meaning that it carries, but also for the scientific facts and values behind these such as prolonged meat life storage, waste products utilization and others. Moreover, meat processing at home may provide our Filipino housewives and meat enthusiasts with skill to contribute with specific rule to perform in the income-generating projects of their own families and communities.

Corresponding with the need for meat processing and the desire of Filipinos to augment their income through meat processing, is also a clamor for research studies to provide references or additional information about the subject. This is our reset is all about.

This research is focused on curing and drying of beef. The researchers identify the salt content and moisture content that would regulate the growth of harmful bacteria which result to spoilage or loss of essential nutrient from the meat. In the process, salt was introduced at different concentrations or dilution in the meat using stitch pumping method. The beef was cured for more or less six days and moisture content was determined at different time intervals. After this the beef which has undergone curing was tested for its resistance to bacterial growth.

B. HYPOTHESIS OF THE STUDY

Since salt inhibits microbial growth by increasing osmotic pressure and lowering water activity, the researchers hypothesized that introducing salt and maintaining a certain amount of moisture content in the meat would really affect the growth of bacteria on the meat. Meat subjected at varying salt contents and varying moisture contents will result to varying rates of bacterial growth on meat samples.

C. OBJECTIVES OF THE STUDY

This study intends to:

1. Determine the salt content and moisture content of beef undergoing curing method of meat preservation that would give it maximum resistance to bacterial growth on the meat.

D. SIGNIFICANCE OF THE STUDY

The research answers the clamor for research studies by providing useful information and additional references about related subjects. The researchers believe that the success of the study could help the people who are into local meat preservation business improve the quality of their products.

E. SCOPE AND LIMITATIONS

The experiment is mainly concerned with beef, and if the same experiment will be conducted with other kinds of meat (pork, mutton, lamb, etc.), the result would be different compared to that of beef because different meats may have different characteristics.

The study involves microbial analysis. It is expected that glasswares to be used must be autoclaved to avoid contamination. Meat samples to be used mustf be fresh and frozen at temperature 28° F to avoid it from undergoing physical and chemical change once exposed to room temperature.

It is expected of experimental procedures to be clear and simple to avoid complicating the methodology. The process in the experiment requires a lot of time and it undergoes different stages.

The researchers do not assure accurate results but they are optimistic that they will come up with successful results that will correspond to what is expected.

Definition of Terms

Meat - the edible part of the muscle of animals especially those of cattle, sheep, swine or goat, which is skeletal or which is found in the tongue, in the diaphragm, heart or esophagus, with or without the accompanying and overlying fat, portions of bone, skin, sinew, nerve, blood vessels which are not separated in the process of dressing.

- in this study the meat refers to beef meat.

Curing - to prepare or undergo chemical or physical processing for keeping use.

Brine - water containing a great deal of salt.

Protein - any of numerous naturally-occurring nitrogen-containing substances that consist of chains of amino acids and are essential constituents of all living things.

Bacteria - any class of microscopic plants that live on soil, water, organic matter, or bodies of plants and animals that are important to man because of their chemical effects and as causers of disease.

Salt Content - percentage of salt found in beef in the curing process.

Moisture Content - ratio of water and other liquid contents in beef to its total weight.

Stitch pumping - a process of introducing salt to meat wherein brine is injected at different parts inside the meat for even distribution of salt. This provides tensile stress that inhibit the growth of bacteria inside the meat.

CHAPTER II

REVIEW

OF

RELATED STUDIES

AND

LITERATURE

CHAPTER II

REVIEW OF RELATED STUDIES AND LITERATURE

There is a scarce research concerning about meat preservation in the Philippines only about cattle breeding and meat livestock. The fact that meat curing has been done from the beginning of time make it a subject of disinterest to local researchers.

The following are the local researches about livestock and cattle breeding:

Le Trong Trung of the University of the Philippines Los Baños referred the appropriate feeding strategy involving untapped feed resources as the key to accelerate meat and milk production in the tropics. He stated that there is an obvious need to satisfy the protein requirements of ever increasing Philippine population. Import dependency is not the answer. The ruminants in the Philippines, just like in many other Asian countries, are found in the hands of small holders who are basically landless crop farmers. Appropriate development strategy must focus on this clientele using whatever available after harvest seasons as bulk of feeds for their animals. Supplements, cheap and locally available, must be given in small quantities to optimize the utilization of the principal diet which is crop residues. There is a need to determine technology packages which are simple, economic, agroclimatically specific to different areas and appropriate to the smallholder livestock farmers.

Below is a table showing human and livestock population in the Philippines taken from Le Trung's research:

Table 1. Human and Livestock Populations ($x\ 10^6$) of the Philippines.

Population	1970	1975	1980	1985
Human	37.54	42.57	48.32	54.50
Livestock				
Buffaloes	4.43	5.05	2.87	4.33
Cattle	1.68	2.25	1.88	1.90
Goats	0.77	1.35	1.45	1.93
Pigs	6.45	4.70	7.93	8.01
Chicken	57.00	46.50	52.76	57.00

R.G. Maghirang, et. al., conducted a study entitled, " An Assessment of Animal Housing System in Beef and Dairy Cattle Farms in the Philippines ", to assess existing practices on housing and climate-related management systems in selected beef and dairy cattle farms in the Philippines. He stressed that adequate housing is of paramount importance for improved breeds of dairy and beef cattle, especially when raised in feedlot or drylot. The amount of space allocated to the animals, and other external conditions are among the factors that may adversely or favorably affect the comfort, health and productive responses of these animals.

De Guzman, studied about the integration of backyard dairy-beef farming with the cropping systems of southeast Asia. According to him, the integration of crop and animal husbandry in particular, backyard Asian agriculture and on the development of the countryside. It should not only raise soil fertility and hence total production per hectare and income per capita, but would also act as a base for further intensification of production and would have a catalytic effect as it would require new and better roads to facilitate marketing of farm produce, utilization of all available farm and industrial by-products, utilization of available farm and finally, improve the living standards of the people .

Researches Abroad

Nutritive Value of Meat and the Stefansson Experiment. As a result of Increased research, the scientific standing of meat as a food has undergone a marked change in the 20th century. In the early 1920s meat was somewhat suspect as an article of diet: it was commonly believed that excessive meat-eating - and some defined excessive as eating it more than two or three times a week – caused such conditions as rheumatism, hardening of the arteries, high blood pressure and kidney trouble. In an article published in the American Mercury in May 1929, Dr. Logan Clendening, professor of clinical medicine at the University of Kansas and a member of the Board of Governors of the American College of Physicians, wrote that while he was "convinced that 'health' warnings against the eating of meat are not only absurd but positively harmful," nevertheless "advice about diet has become so impassioned and so

involved in the United States of late that in some quarters it even acquires a plot and takes on the aspects of a ritual drama. In this drama meat is cast for the role of a villain."

About this time however, signs of a turn of the tide began to appear as scientific workers published results that cast doubt on some of the adverse thinking about the nutritive value of the meat. The definite turning point came after Vilhjalmur Stefansson, the Arctic explorer, and an associate, Karsten Andersen, followed an all-meat diet at Bellevue Hospital, New York, in 1928 and 1929 under the observation of a committee of scientists. The chairman of the committee was Dr. Raymond Pearl of Johns Hopkins University, who was assisted by Dr. Eugene F. Dubois, medical director of Russell Sage Institute of Pathology, and others.

This unique experiment developed in this way: Stefansson had lived for years in the Arctic on an all-meat diet or its equivalent and was convinced that meat was not harmful in any way. An anthropologist of standing, a man of conviction, and a keen observer with an unusual clarity and facility of expression, he returned to the United States after his Arctic experiences to lecture. At one of his lectures, given in 1920 at the Mayo Clinic in Rochester, Minn., one of the Mayo brothers suggested that Stefansson had a checkup to see whether his all-meat diet had affected him. He was unable to do so at the time but later discussed the matter with a gastroenterologist in New York, who volunteered to gather a committee of specialists to examine him. This was done, and the physician, Dr. Clarence W. Lieb, reported in the Journal of American Medical Association of July 3, 1926, that the committee had failed to discover any harmful effects of Stefansson's all-meat diet.

Some scientists concluded however, that while an exclusive meat diet might be satisfactory in a cold climate under the strenuous conditions experienced there, it was doubtful whether a human being could exist in a temperate climate for long on such a diet. Stefansson was determined to dispel such doubts and proposed to the meat industry that it finance an experiment. For various reasons, the industry was somewhat reluctant to do so, but Stefansson's arguments were persuasive and, after much discussion and negotiating, agreement was reached and the experiment undertaken. This was done not to promote an all-meat diet, for all the meat produced is consumed, but to establish scientifically the healthfulness and nutritive value of meat.

Publication of a number of scientific papers followed the experiment. They were summarized in effect in this comment which Dr. Lieb made later:

"During the year on exclusive meat diet, 1928-9, both men said they felt better than average for them. Both looked it and were in so far as I could tell through the clinical and laboratory studies which I made of them before, during and after. The like, I believe, was the verdict of the rest of those intimately connected with the experiment.

Stefansson and Andersen are in health today at or above the average of their years. Neither so far as I could tell, has to date suffer any ill effect either from the numerous previous years during which they had lived exclusively or mainly on meat."

Composition of Meat

Table 2. Mineral as a Source of Proteins, B Vitamins, and Food Iron

(All ratings based on cooked value)

Kind of Meat	Complete Protein	B Vitamins			Food Iron
		Thiamine (B1)	Rivoflavin (B2)	Niacin	
Pork	excellent	excellent	fair	excellent	excellent
Beef	excellent	fair	excellent	excellent	excellent
Lamb	excellent	fair	good	excellent	excellent
Veal	excellent	good	good	excellent	excellent
Variety meats(liver) heart, kidney)	excellent	excellent	excellent	excellent	excellent
Sausage (frankfurters, bologna)	excellent	good	good	excellent	excellent

Table 3. Approximate Mineral Content of Various Meats

(200-gram edible portion, uncooked)

	Beef round	Lamb leg	Pork loin	Veal shoulder
Total minerals	2.0 gm	1.8 gm	1.8 gm	2.0 mg
Calcium	22 mg	20 mg	20 mg	22 mg
Chlorine	147 mg	136 mg	125 mg	147 mg
Copper	0.2 mg	0.2 mg	0.2 mg	0.2 mg
Iodine	0.02 mg	0.03 mg	...	0.01 mg
Iron	5.8 mg	5.4 mg	5.0 mg	5.8 mg
Magnesium	46 mg	42 mg	39 mg	46 mg
Phosphorous	360 mg	426 mg	372 mg	398 mg
Potassium	661 mg	610 mg	559 mg	661 mg
Sodium	164 mg	152 mg	139 mg	164 mg
Cobalt	0.0002 mg	...	...	...
Manganese	0.03 mg	0.03 mg	0.02 mg	0.03 mg
Zinc	9.4 mg	...	...	...

As shown in Table 2, meat is rich in complete, high-quality proteins and in certain vitamins and minerals and also is a good source of energy. Its value as a protein lies in the fact that it provides adequate amounts of all the essential amino acids: tryptophan, phenylalanine, methionine, and lysine, among others. Scientific research has established the fact that lysine, methionine, and trytophan xcontained in meat are all well utilized. This fact is of significance, for these three acids are thought to be most limiting in human diet. In addition, meat furnishes important amount of the vitamin B complex , which includes thiamine, riboflavin, niacin or nicotinic acid, pyridoxine, pantothenic acid, folic acid, and cobalamin.

As customarily consumed, meat makes an important contribution to the mineral needs of the diet except for calcium and iodine. Among its minerals are those required in substantial quantities as well as those required only in trace amounts. Table 2 gives the approximate amounts of essential minerals provided by muscle meat when 200 grams are consumed. The minerals include those known to be essential components of the human organism-the skeletal framework and the teeth, soft tissue structures including blood, and substances concerned in regulatory functions.

Governments often establish meat quality standards based upon such highly variable properties as marbling and maturing and also upon factors as color, firmness, and texture. The Codex Alimentarius Commission sponsored by the Food and Agriculture Organization and the World Health Organization, was established in 1961 to consider uniform international food standards. In the early 1970s the Codex Committee on Meat and Meat Products was working

on a classification and grading system for carcasses and cuts of beef, lamb, mutton, pork, and veal and was also considering hygiene standards for fresh meat.

Research has been important to meat-packing business ever since uses first began to be found for the tremendous quantities of waste materials that were concomitants of meat making. This importance has grown steadily over the years, and the number of professional and technical research workers in packinghouse laboratories has increased manyfold.

In addition to the extensive laboratories maintained by individual companies, the industry supports the American Meat Institute Foundation, a research laboratory affiliated with the University of Chicago. Results of the foundation's research include the establishment of the causes and the means of prevention of various types of discoloration of sausage, vinegar-pickled meats, and other products; the development of two outstanding antioxidant compounds for the prevention of rancidity in fats and foods made with animal fats; the development of a pure culture for positive, rapid flavor production in summer sausage and other products of the fermented type; and the introduction of the use of by-product animal fats in poultry and other mixed feeds, thereby providing a new market for millions of pounds of tallow and grease. The foundation also obtained positive information on the cause and means of prevention of certain types of bacterial food poisoning; developed information of major importance relating to the nutritional values of meat and meat products and similar information relating to the nutritive value of meat and bone meal feeds for poultry and swine; provided practical information on land processing, smokehouse control, the dehairing of hogs, and the control of rendering

temperatures; and developed basic information on beef tenderization, dehydration, and the irradiation treatment of meat.

Research investigations in progress at the foundation in the late 1950s were concentrated on the following fields: (1) meat preservation, including irradiation, ntibiotics,packaging , bacteriology of cured meats, bacteriology of canned hams; (2) beef tenderization, including high temperature aging, tenderizing agents and chemical studies; (3) processing studies, including those of pure culture starters, quality control and instrumentation, and water binding; (4) meat color and discoloration; (5) the chemistry of animal fats, including anti-oxidants, oxidation studies, and rancidity in pork products; (6) animal fats in deep fat frying and in chilled doughs, (7) the nutritive value of meat including the B Vitamins and utilization of amino acids; (8) nutritional studies of meat and bone meal and animal fats for feed use; (9) chemical studies of cattle hides; and (10) quality control analysis.

CHAPTER III

METHODOLOGY

CHAPTER III

I. METHODOLOGY

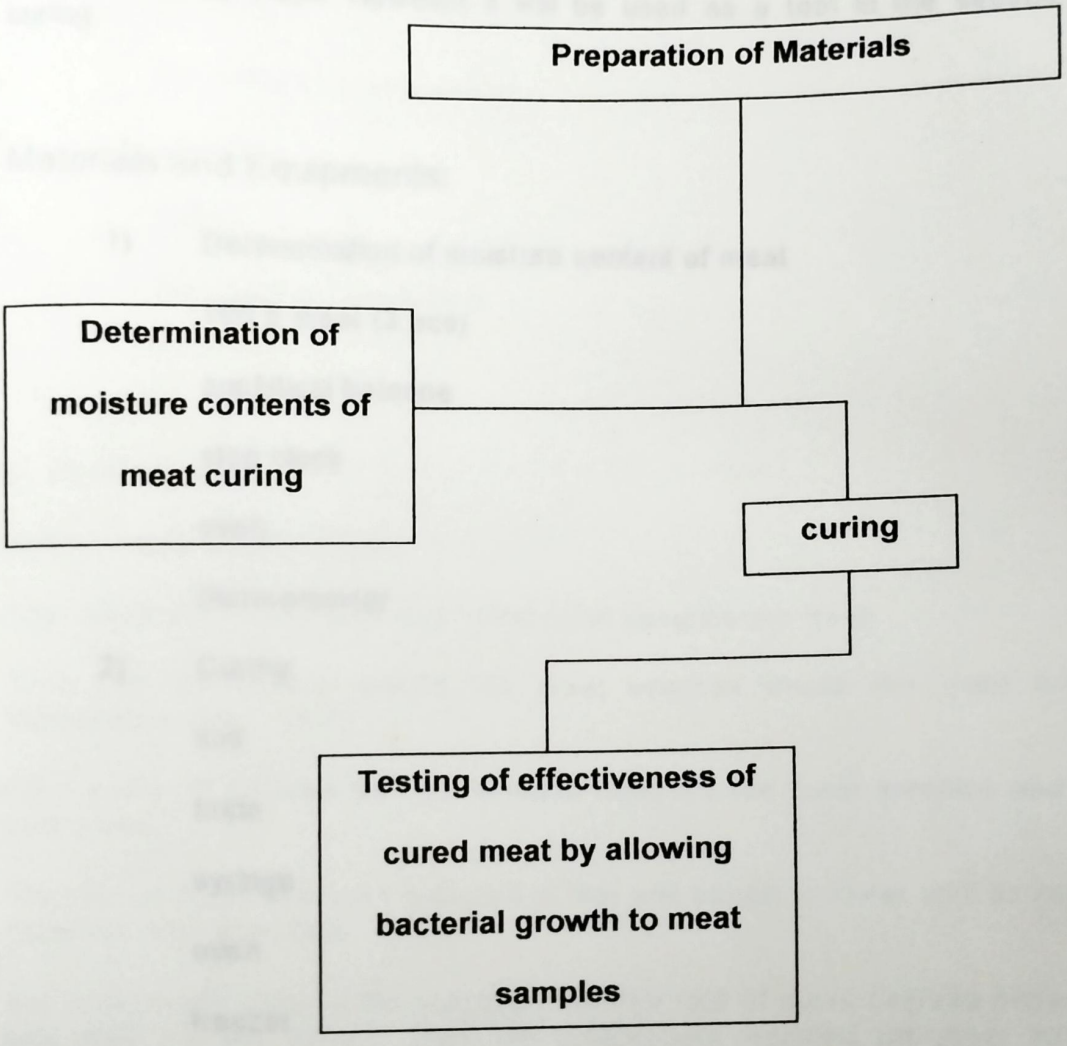

Figure I : Schematic diagram of the research design

The entire process includes three steps

a) determination of % moisture content of meat

b) curing

c) testing for effectiveness of cured meat

The determination of moisture content of meat has no relation on the two proceeding steps. However it will be used as a tool in the second step which is curing.

Materials and Equipments:

1) Determination of moisture content of meat

100 g meat (3 pcs)

analytical balance

stop clock

oven

thermomerter

2) Curing

salt

brine

syringe

oven

freezer

evaporating dish

100 g meat (3 pcs)

strainer

3) Testing for effectiveness of meat

agar

petri dish

blender

incubator (not necessary)

pipettes

knife

cured meat from step b

Methods / Procedure

A) Moisture content determination

1) The researcher made sure that 100 g meat samples are fresh

2) Then the researchers placed the meat samples inside the oven and heat at temperature 90° - 100°.

3) After every 30 minutes the rtesearchers removed the meat samples and measured their mass.

4) The rate of mass decrease was fast at first and began to lower until its rate of mass decrease was near zero.

5) The reseachers stopped the process when the rate of mass decrese became zero or less than 1 g per minute. Then the researchers weighed the meat samples and solved for its moisture using the formula below. The researchers also used the other formulas provided to solve for rate of mass decrese and others.

M% =% moisture content

M = mass of meat samples

Md = mass of dried meat

M%=Md / M

Mc = moisture content of meat

Mc = M – M (M%)

Mr = rate of mass decrease (every thirty minutes)

M1 = initial mass of meat sample

M2 = mass of meat sample after 30 minutes

Mr = (M1- M2) / 30 minutes

A) Curing

1) The researchers prepared all the needed materials and made sure that the meat was fresh and the glassware were sterile.

2) Then the researchers prepared 15 %, 20% and 25% salt solution.

3) After that, the researchers immersed the meat samples to the different dilutions of salt for at most one-minute. The researchers used the syringe to inject 50 ml of

brine at various points of meat samples. The brine injected to meat were of the same dilution on the salt solution it was immersed.

4) Then the meat samples were placed on evaporating dish.

5) The meat samples were placed in the freezer for 4 – 6 days.

6) Then the researchers removed the meat samples from the freezer and placed it in the dissector to thaw for several minutes. Then the excess liquids were drained after thawing.

7) Then meat samples were placed in oven and heated at temperature 90°-100°.

8) The meat samples were weighed every thirty minutes and its moisture content were solved.

9) Then the process was stopped immediately when the moisture content were already 10%.

10) The meat samples were stored in the dissector for the next experiment. The observation was recorded.

11) The process was repeated using 15% and 205% moisture content.

B) Testing for effectiveness of cured meat samples using bacterial culture.

1) The researchers made sure that glassware used in this experiment were autoclaved before using.

2) The researchers cut a 50 g meat on each meat sample and blended it with 450 ml distilled water.

3) The researchers placed 15 ml of agar into petri plates aseptically. The temperature of agar was at most 45° C or hot enough to handle. The agar was allowed to cool and solidify.

4) Then pipettes were used to carefully pour 0.1 ml of blended meat samples to designated petri plates and spread away.

5) The petri plates with agar and meat samples were placed inside the incubator at 35° C and were incubated for 48 hours (do not exceed up to two and a half days).

6) The numbers of colonies were counted and observations were recorded.

CHAPTER IV

RESULTS, OBSERVATIONS, AND DISCUSSION

CHAPTER IV

Results and Discussion

A) Results and observations on determination of moisture content of meat done last October 4, 1997 in science research laboratory

Three separate meat samples were placed inside the oven and heated at temperature 90°-100°C with their mass and rate of mass decrease every 30 minutes noted. The table below summarizes the result of the experiment.

Table 4. Experiment on moisture content determination of meat.

		Mass of beef (g)	Rate of mass decrease (g/m)
Initial mass		100g	0
After	30 minutes	98	66
	60 minutes	95	1.00
	90 minutes	91	1.33
	120 minutes	86.5	1.50
	150 minutes	83	1.17
	180 minutes	81.5	.5
	210 minutes	80.3	.4
	240 minutes	80.1	.06

270 minutes 80.002

300 minutes 80.00

A) Curing and testing for effectiveness of storage lie of cured meat.

The experiment was done in three separate days. The first experiment was done with meat samples dried with 10% moisture continuity left. These meat samples had varying salt contents at 15%, 20% and 25% salt solution. The second experiment was done with meat sample having 15% moisture content and third having 20 %. The table below shows the overall result of the experiment.

Table 5: The effectiveness of cured meats in limiting bacterial growth.

Dilution of salt	No. of colonies after two % moisture content of meat		
	10	15	20
15%	5	8	13
20%	7	10	17
25%	8	14	20

CHAPTER V

SUMMARY OF SIGNIFICANT FINDINGS, CONCLUSIONS AND RECOMMENDATION

A) SUMMARY OF SIGNIFICANT FINDINGS

a) Experiment on the determination of moisture content of beef.

This simple experiment was done only to determine the percent moisture in meat. The zero rate of mass decreases show that the meat has dried and lost all its moisture content. The mass of the dried meat will then be divided by the initial mass of the meat before drying. The result is the ratio of the solid part of meat to its whole mass. We can then determine the percent of moisture in meat by subtracting the percent of solid part of meat to 100%.

Initial mass of meat = 100 g

Mass of dried meat = 80 g

% dried part = 80 g/100 g

=.80 or 80%

% moisture = 100 % - 80
= 20%

b) Curing and testing for effectiveness of cured meat.

After curing, the meat must be tested for its effectiveness of preservation by allowing bacterial growth for two days. There are two factors influencing meat preservation in this experiment: salt content and moisture content.

Table 6. Salt content as a factor in meat curing

	Dilution of salt		
	15%	20%	25%
No. of bacterial colonies found in three meat samples (n)	26	34	42
n/3	8.67	11.33	14

The table above shows the effect of different dilutions of salt in meat curing excluding the second factor, which is the moisture, content. The table shows that there is no big difference to the number of bacterial colonies. The cured meat having 15% salt solution is the most effective among the other two.

Table 7: Moisture content as a factor in meat curing

	Moisture content		
	10%	15%	20%
No. of bacterial colonies found in three meat samples (n)	20	32	50
n/3	6.67	10.67	16.67

The table above shows the effectiveness of cured meat excluding the factor dilution of salt. The cured meat with 10% moisture content is the most effective since only few bacterial colonies grew after two days of incubating. Note that there is a small difference in values between 10% and 15% moisture contwent compared to between 15% and 20% moisture content.

B) Conclusion

Basing on the results of the experiments, the researchers conclude that cured meat injected with 15% solution of brine and having a moisture content of 10% is the most effective in having a lesser number of bacterial colonies. The researchers suggest that local meat enthusiasts who are into meat curing business use this method in of curing their beef meats.

C) Recommendations

The researchers recommend that there should be further studies about meat preservation especially meat curing since meat curing is always part in preparation of meat products such as ham, tocino and etc. Thay also suggest that there will be further studies not only about beef meat but also about other kinds of meats as well like pork, veal, mutton, etc.

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