Effect of Mild Smoking Time on Some Physical Properties of Chicken Breast

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DECLARATION

I hereby declare that the work embodied in here is the result of my own research except for the excerpt as cited in the references.

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ABSTRAK

Ayam salai yang dimasak dengan api yang sederhana sangatlah jarang ditemui dan didengari oleh masyarakat sekarang namun mereka sering dengar salai dalam keadaan yang panas dan sejuk kerana telah digunakan zaman berzaman. Salai ialah satu preservatif makanan dan suhu salai dalam keadaan api yang sederhana kebiasaanya dalam30ºC - 50ºC kerana suhu itu adalah antara tengah tengah panas dan sejuk lalu diikuti masa yang diambil dalam 0, 1 dan 2 jam. Secara keseluruhan, ramai orang yang memakan ayam kecuali mereka yang langsung tidak makan daging. Ayam yang pra-dirawat adalah ayam yang di rendam dengan garam semalaman untuk penyahaktifkan mikroorganisma. Projek ini bertujuan untuk menyelidik fizikal ayam tersebut dengan betul dari segi warna, kelembapan, nilai pH dan kehilangan jisim pada ayam yang pra dirawat. Data daripada ayam itu akan diperoleh untuk mempelbagaikan dan menambah nilai dari Universiti Malaysia Kelantan. Kesan salai sederhana akan dikaji dari segi fizikal yang betul untuk tujuan pembelajaran masa hadapan dan untuk mengukur tahap kesalaian.

Kata kunci: Salai sederhana, fizikal yang betul, ayam pra dirawat

ABSTRACT

Mild smoking on chicken are rarely found and hear from citizens but when it comes to the hot and cold smoking, it was familiar to hear and have being used a long time ago. Smoking is a preservation of food and mild smoking (30ºC - 50ºC) is a middle of cooking between cold and hot smoking following the set time in 0, 1 and 2 hours. Chicken has been consumed by a lot of people in globally excluded vegetarians. Pre-treated chicken is a chicken that has been treated with brine or salt solution for one night for process of microorganisms inactivation. This project is purposed to investigate some physical properties of the pre-treated chicken breast in terms of colour, moisture content, pH value and weight loss. The data will be obtained to diversify and add value to chicken based product in globally for generally and in University Malaysia Kelantan for specifically. Effect of mild smoking time of pre-treated chicken breast would give ideas for future studies in investigating the physical properties and measure the smokiness level.

Keywords: mild smoking, physical properties, pre-treated chicken

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CHAPTER 1

1.0 Introduction

1.1 Research Background

Food deterioration is the process or chemical or physical change of food that cannot consume by human. Frequently, the contaminates of food were caused by microbial activity, insects infestation or spoilage of enzymes by food itself. Foods are procured from plant and animal sources, normally it will start to spoil shortly after harvest or slaughter because of the elements in food are being oxidize. The enzymes that are embodied in the plant cells and animal tissues are starting to breakdown and food quality begins to low, in terms of the deterioration of texture, flavour and the loss of nutrients. Water is universal and contained in foods by microorganism and chemical reaction. Besides human, plants and animals, microorganisms also required water to breakdown molecules in food and used for growth and energy. Water provides waste products to leave out from the cells. Besides, chemical reactions occur to supply moisture in food.

Hence, food preservation was introduced to kept food securely and prevent from spoilage after harvest and slaughter. Example like mango pickles for plant and smoking chicken for the animals. Fermentation, drying, refrigerating are the oldest method to preserve food while canning, freezing, pasteurization, irradiation and also addition of chemicals like salts and sugar are the modern methods for preservation. Besides preservation of food, the packaging materials of food had play an important role for restrain the product in the storage to strength the lengthen time of products, stay fresh, juiciness and more. (R. Paul Singh & Norman Wilfred Desrosier, 2018)

Next, different techniques such as drying, freezing and addition of chemicals have been used for poultry preservation. Previous studies have reported that oldest traditional techniques especially smoking can lengthen the shelf life (Rahman MS. *et al*., 1999). Burning woods are used to smoke and also can use liquid smoke to conserve poultry products like chicken by looking at the antimicrobial and antioxidant properties that are effect on the exposed surfaces of the food (Rahman MS. *et al*., 1999 & Lingbeck JM. *et al*., 2014). Thus, smoking also had be been discovered by some researchers that can effect the color and flavor in variety of poultry products (Rahman MS. *et al*., 1999 & Janky DM. *et a*l., 1976).

Most consumers demand to get safe, convenient, differ, safe, attractive in terms of appearance, texture, odour and taste also the nutritious of products. The terms of convenience products is most of the consumers will prefer food that "ready to eat" directly or after heating up. Different consumer priority are the primary cause for scientists and manufacturers evolving new food products. In current years, there has been a expand demand for poultry and poultry products.

Therefore, the present study will investigate the mild smoking

1.3 Hypothesis

H_o = Increasing smoking time cannot improves the quality of physical properties.

H_1 = Increasing smoking time can improves the quality of physical properties.

1.4 Scope of the Study

The use of mild smoking using charcoal at various time exposure (0 hour, 1 hour, 2 hours) will be applied. Physical (moisture, pH, colour, weight loss) being observed and recorded once it done.

1.5 Significance of the Study

Mild smoking uses a relatively lower heat than hot smoking. It combines the aspect of smoke penetration without fully cooking the material which would change the overall quality of the product for future cooking. Cold smoking would not be able to be conducted through traditional method at a Malaysian environment. The combination of mild smoking, with sun drying should lead to reduce bacterial progression and allowing smoke to penetrate the meat. Having smoke material that is not fully cook gives the meat material a much better texture for future cooking application. Brine…

1.6 Problem Statement

Smoke products from Malaysia normally are produced via hot smoking. Hot smoking will readily cook the material, leading to possible lower quality material if intended to be used as a meat material for cooking. Cold smoking using traditional smoking approach cannot be applied in Malaysia due to the environment (hot and humid). Mild smoking involves smoking with reduced heating elements, but still allowing the product to have the smokiness flavour without too much structural integrity, making the product more appropriate to be used in cooking.

1.6 Aim and the Objective

1) To evaluate mild smoke chicken breast at various time intervals

2) To measure physical properties of mild smoke chicken.

CHAPTER 2

2.0 Literature Review

2.1 Food Spoilage

The populations history and society among the natural world is stringently close to the manage of raw materials found in the world and the ways of processed to preserve it and to prevent any spoilage from it. The information from archaeologic artefacts, they starting to learn discover the nature were unrevealed to keep raw foods for instance meat, fish, and vegetables for salting and sugaring, drying, and smoking. Dried fish, meat and vegetables, smoked products, ripened and salted meat and fruit preserves were discover between most archaic, ethnic, and history of lifestyle among populations diets that can be found in traditional food products. Therefore, salting and smoking are contemplate as traditional preservation.

There are two types of the microbial contamination which are bacteria (*salmonella* spp.) and fungi such as yeasts (s*accharomyces* spp.) and mold (*rhizopus* spp.) that can effect food-borne illnesses and food spoilage. Oxygen will increase the microorganisms growth because some bacteria need oxygen for grow and this is called aerobes. Next, some of them does not require oxygen (anaerobes) to grow and also many bacteria that are facultative anaerobes that can grow under both condition. Molds and yeast are also need oxygen to grow to form spoilage in food and existing of air surround the environment they can regularly be found spreading on the surface of foods.

2.2 Traditional Preservation

Techniques of old preservation including salting, drying and smoking by finding the progression comprise the food processing origins, advancement of the modern technologies, and the involvement of food science research. Empirically evolved is the main of the input to the evolution from traditional to processes of science-based and then the conception of water activity (a_w) were introduced and the role in the inhibition of biochemical, chemical reactions and microbial growth.

Nowadays, processed of products are contrasting to obtain a minimizing in a_w as called as "intermediate-moisture foods" (Karel, 1976). They are distinguished by contents that have high moisture compare to dry foods yet consumable lacking or absent of the dehydration. Next, they are produce to be shelf-stable without stored and distributed to refrigerate (Taoukis & Richardson, 2007). Therefore, new learning about water–food interactivity was providing a methodological optimization of traditional preservation techniques to get better quality of food products with the reduction of a_w.

2.3 Microbial Growth and Water Activity (a_w) of Moisture Control

Microorganisms can grow in a controlled range of a_w, that are differ rely on the species and strain (Carlin et al., 2013). Table 1 shows a_w of the minimum values for some major pathogens of foodborne when use salt (NaCl) to reduce the a_w. Although, the same microbial are growth at different minimum a_w whenever various humectants are used like sugars or glycol, and the osmoregulation determined by the cause of osmotic shock (Chang et al. 2014). Thus, a reduction of a_w were present as a important stressor, which is resolute for survival of microbial cell. It is common that the microbial cell response to osmotic shock is frequently connected to the compatible solutes accumulation in the cell. Compatible solutes were known as a polar and water-soluble compounds which can confine an osmotic shock that are able to accumulate in the cytoplasm without destroyed the cell physiology.

Table 1.1: Minimum a_w on specification of foodborne pathogens

Microorganism	a_w (min) (NaCl)
Campylobacter spp.	0.987
E. *coli* O157:H7	0.95
Vibrio parahaemolyticus	0.94
Salmonella spp.	0.93
Bacillus cereus	0.92
Listeria monocytogenes	0.90
Staphylococcus aureus	0.86

2.4 Smoking

Archaeologic discovering the revealed of the smoke usage in food preparation 90,000 years ago (Möhler, 1978), likely as the use of fire for drying and food preparation which that have a longer shelf-life and upgrade the sensory properties of food. The real aim of smoking is extend the preservation attained by drying surface with a reduction in a_w, preventing growth of microorganism, and a suspended of lipid oxidation.. Nevertheless, it also can change the colour, texture, smell, and flavour and enhance the mainly sensory satisfactory of foods.

Smoke is a difficult system of vapor ceaseless spreading phase form of solid particles and liquid droplets in nano size. The existing of phenolic compounds can adsorbed by the food in the processing and able to perform the taste and aroma of smoked products like guaiacol. The colour appearance of the food in smoked products is adequate to the chemical and physical reactions that occur during the process. The most major are smoke adhesion of coloring compounds, oxidation of the smoke components such as phenols and aldehydes, polymerization and the results of compounds in the smoke with proteins, specifically between smoke carbonyl groups and amino groups of proteins on the surface of food.

The treatment is depend on food exposure to smoke released from the incomplete combustion for instance sawdust or cut from hardwoods. The method has been enhanced by improving the location of the product with respect to fire and setting the time and surrounding temperature. Smoking is represent at low temperature basically at 15–25°C and called as cold smoking and for the hot smoking, need high temperature about 50–85°C. Most point of the smoked products are initially to cure and preserve.

Hot smoking and cold smoking were different temperature and process, but the results and aim still the same which to maintain the quality and security of foods. Smoking is the term of appearing heat to look for cooking effect, low in moisture, decreasing microbial growth and rely on the process preparations, may assist some ripening by encouraging enzymatic action. Cold smoking is mostly worked for flavor and for lengthen shelf-life causing by the antioxidant and antimicrobial reactions of smoke compounds.

Smoking can apply a bacteriostatic reactions that relies on a composition of phenolic compound concentrations and other obstacle like an example is salt for the preservation. Besides, temperatures are normally too low in cold smoking to perform slow the growth of foodborne pathogens like *Listeria monocytogenes*. Hence, this is show of how crucial food safety preserve, detailed by many outbreaks of foodborne disease and product recalls (Tocmo et al., 2014). There is a explicit bias for lessen the fat content and salt through moderately smoked fish and meats also eliminating the preservatives from the product, but if stored in the same shelf-life under refrigeration it may lead to thermal abuse. Thermal abuse is something cold was contact with anything hot and distract the their temperature and also thermal equilibrium may occur. Antimicrobial packaging and also food biopreservation by natural compounds occur in foods were need to control the occurrence of *L. monocytogenes* in these products (Paparella, Serio, Chaves-López, & Mazzarrino, 2013).

2.5 Salting

Therefore, high temperatures quickly slow the growth and movement of microorganisms and less times give plenty unwanted changes in quality of food (Ohlsson, 2002). Heat-shock is a high in temperature and it is a short time technique spread to horticultural products that generally required a washing step less than 5 minutes at a temperature range of 45°-70° C. Heat-shock can upgrading the quality and bactericidal effect of sanitisers (Martin-Diana, Rico, Frías et al., 2006). Heat treatment have three popular techniques which are vapour heat treatment, hot water immersion treatment and forced hot-air treatment. Three of them are used for decontaminate and disinfest produce. The timing of the preparation before or after processing of heat treatment is very crucial for maximizing its advantageous effects (Barry-Ryan, 2012).

Prehistoric Chinese and Egyptians were used the salt for mummification (Cappelli e Vannucchi, 1990) and back to 1000 BC in dating system, some Northern European countries were verify in use of salt as a meat preservative then followed by the Roman empire. Therefore, the salt usage was narrowly enclose connected to the economic wealth of valuable salted foods, such as cheese. According Safety of Traditional and Ethnic Foods, the existing of nitrite in brines used to salting the meat was revealed and attributed for the colour meaning that it will maintain the redness of meat and constancy of products.

Having nitrate as a antimicrobial action against which are pathogenic bacteria (*Clostridium botulinum*) is the source of nitrite along the reduction process (Lawrie, 2006). Salting can be prepared using brines or dry salt. Dry salting is the traditional treatment and mostly used for fish and meat products. It requires external treatment with salt alone or in a mixture with other ingredients and additives such as nitrites and nitrates, sugars and spices.

Next, foods that are keep at low temperatures which is 1°C to 4°C for long times sufficient for the direct amount of salt to penetrate the flesh, fortify stable and secure products. Salt penetration experience two processes which are formation of a saturated solution on the surface of the product and emigration by transmission inside the product. It happened when osmotic pressures between the interior and the surface, removed the water toward the outside and dehydration of the flesh.

The ending of salt concentration depending on type of raw material, size and features of the salt including particle size, temperature and time of salt product contact. Salting for the meat products is usually comes by partial drying and ripening which decrease the moisture content and a_w, enzymatic activity and microbial growth will be slow and also chemical respond proportions depend on the salt content and a_w, then finally provide the stability and quality of the product.

A salt concentration between 2.0% and 3.5% have a conditions favor for the fermentative bacteria for instance lactic acid bacteria, *Leuconostoc mesenteroides* to grow of lactic acid desirable for stability (Hang, 2003). Salt solution or wet salt or brine also involving other ingredients and additives. Products are immersed in brines like chicken and meat long enough to let the solution penetrate and preserve the food.

The brine salt concentrations for meat is 15% and for the cheese is 25% determined on the product. Vegetables like cucumbers, olives and onions are use lower salt concentration (2–6%) for worked with the aim of fermentation enhance and preventing the development of spoilage and pathogenic bacteria. Wet salting also able to be practice with injection of a salt solution. Moderately salted meats made with large muscle pieces such as meat and ham.

Since past, salting was crucial in food preservation and the prevention consequences of salt on microbial growth and production of toxin are familiar. Salted foods is a secure

foods for citizenry because the value of a_w will slow the growth of microbial activity that can cause disease. Salting and curing yet were meet a new problems because of globalization and economic crises.

2.6 Chicken (Poultry Product)

People that consume foods must be able to differentiate between foods based on the nutritional of each to healthy diet and foods in a boarder context in production of food for instance food safety. Thus, chicken can be categorized as method of healthy eating and it is main source of protein. Chicken breast is the main cut consumed and it contain low in fat with polyunsaturated profile better than saturated fatty acids. Furthermore, chicken is the most affordable meat source that also contains vitamins and minerals in chicken meat. Stir-fried lean chicken breast had more than 55% unsaturated fatty acids such as monounsaturated and polyunsaturated fatty acids compared to other stir-fried meat sources. Although, chicken breast had removal skin, the amount of micronutrients and niacin were increase.

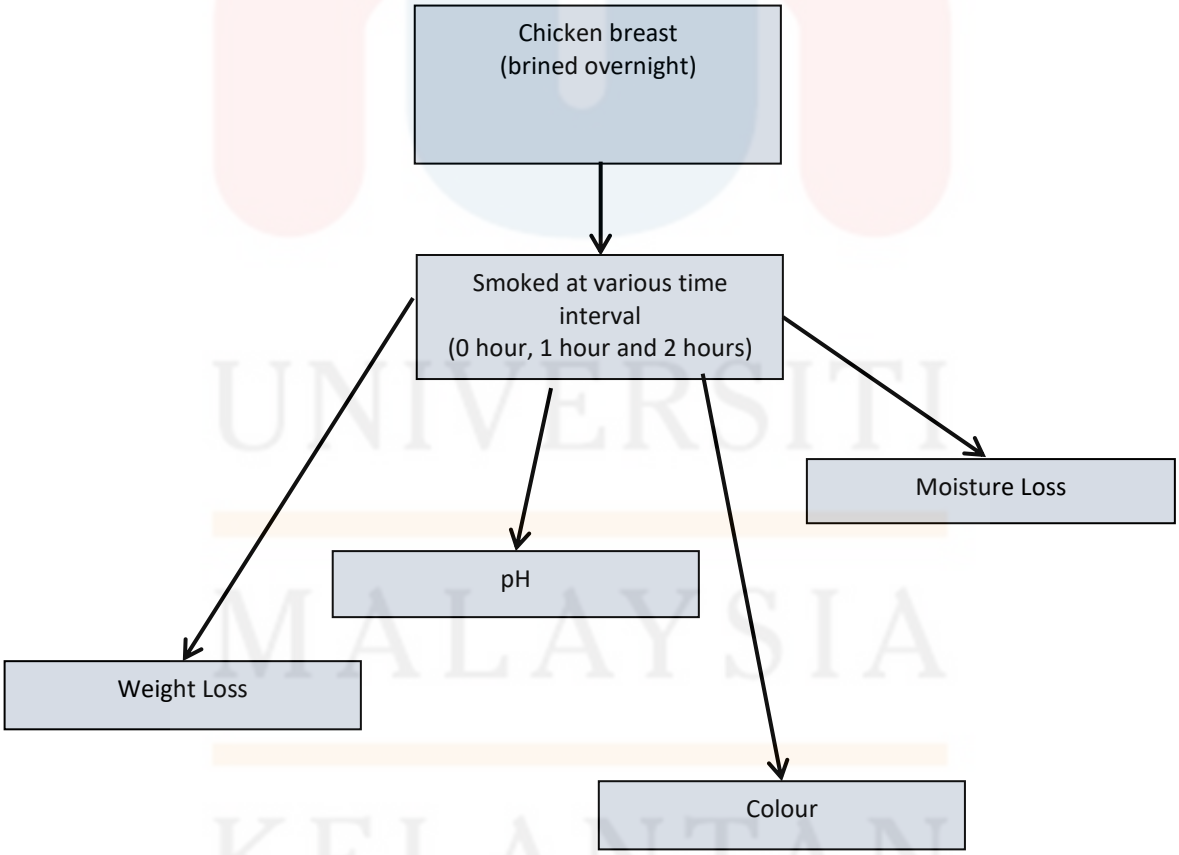
The storage of chicken must be stored up to 60ºC and leftovers of the chicken must be frozen and kept for one to two days only in the fridge. Next, the leftovers had to be reheat at least 70ºC for minimal two minutes. Listeriosis is not considered to be a serious risk from chicken meat. Basically, chicken is consumed during hot right after cooking and the leftovers need to be kept in the fridge as well within a day for buy or cooking purpose.

CHAPTER 3

3.0 Methodology

3.1 Experimental Design and Site

In this study, a total of 6 chicken breasts were randomly selected and test in physical properties on mild smoking. The chicken breast were divided into two 2 groups of 3 chicken breasts each: control and brine, and were taken time of smoked on 0 hour, 1 hour and 2 hours. This experiment was conducted at Food Laboratory, UMK Jeli Campus.



3.2 Sample Preparation

In this experiment, salt solution were used for brine chicken breast overnight. Skin of chicken breast were removed before start the experiment. Chicken breast was given by supervisor and the experiment was run in Food Laboratory, UMK Jeli Campus. The control in this experiment was chicken breast without brine solution while chicken breast with brine solution was the sample that had been investigated.

3.3 Smoking Time

The mild smoking chicken breasts was recorded at 0 hour, 1 hour and 2 hours. Charcoal had used to make smoke. Weight loss, colour, pH and moisture loss were measured during this experiment.

3.4 Physical Properties of Chicken

3.4.1 Weight Loss

Each of chicken breasts were measured using weighing balance. During the experiment, chicken breast were calculated the amount of weight for raw chicken which taken for 0 hour smoked, then continued with 1 hour and 2 hours of control. The weight loss of chicken breasts with brine solution were taken for raw chicken, after brine or 0 hour smoked, 1 hour and lastly 2 hours smoked.

3.4.2 Calorimeter

The calorimeter of 6 chicken breasts were determined by colour of chicken breast that had been rate for L* indicates lightness, a* indicates red/green and b* indicates yellow/blue. For the control, the chicken breasts were identify their colour based on 0 hour, 1 hour and 2 hours of smoked. Next, for the brine chicken breasts, they were identify by after brine (0 hour smoke), 1 hour and 2 hours.

3.4.3 pH

During the experiment, pH meter were measured using pH meter for control at 0 hour, 1 hour and 2 hour of smoked chicken breasts. Next, chicken breasts with brine were measured at 0 hour, 1 hour and 2 hours of smoked.

3.4.4 Moisture loss

Microwave were used to defined moisture loss in smoke chicken breast and was evaluated after 2 hours then weighed it. Moisture loss was calculated using this formula:

$$\% \text{ Moisture} = \frac{\text{Loss in moisture (g)}}{\text{Initial weight of sample (g)}} \times 100$$

Loss in moisture = Initial weight (g) - Final weight (g)

Initial weight of sample = Wet or original weight of sample before drying

Final weight = Weight of sample after drying

3.5 Analysis Data

All the data were subjected to analyse using Microsoft Excel statistical analysis. The data that were evaluated are weight loss, pH, colour and weight loss.

CHAPTER 4

RESULTS AND DISCUSSION

4.1. Weight Loss

Table 1.2: Weight loss (g) between control and brine (Mean ± SE)

Smoke Time (hours)	Group (g)	
	Control	Brine
0	140.89 ± 3.96	149.95 ± 7.74
1	94.70 ± 2.66	110.46 ± 5.61
2	61.54 ± 2.62	83.35 ± 5.05

Control: Chicken breast without brine
Brine: Chicken breast with brine

Table 4.1.1 shows the mean of weight loss between control and brine for each chicken breast in smoking time. According to the table 4.1.1 weight loss of the experimental chicken breast were decrease from 0 hour to 2 hours due to the heat. At 0 hour and 1 hour, the differences between control and brine were significantly differences and the average of weight almost same which are (140.89 ± 3.96) and (149.95 ± 7.74) respectively. Next, at 1 hour to 2 hours later, the weight for both control and brine were decrease and significantly differences which are (94.70 ± 2.66) and (110.46 ± 5.61) respectively. At the initial to final point (0 hour and 2 hours) of smoking time, they were significantly differences in loss weight of chicken breast which are (61.54 ± 2.62) for

control and (83.35 ± 5.05) in brine. Thus, there was statistically significant difference between the control and brine ($p < 0.05$).

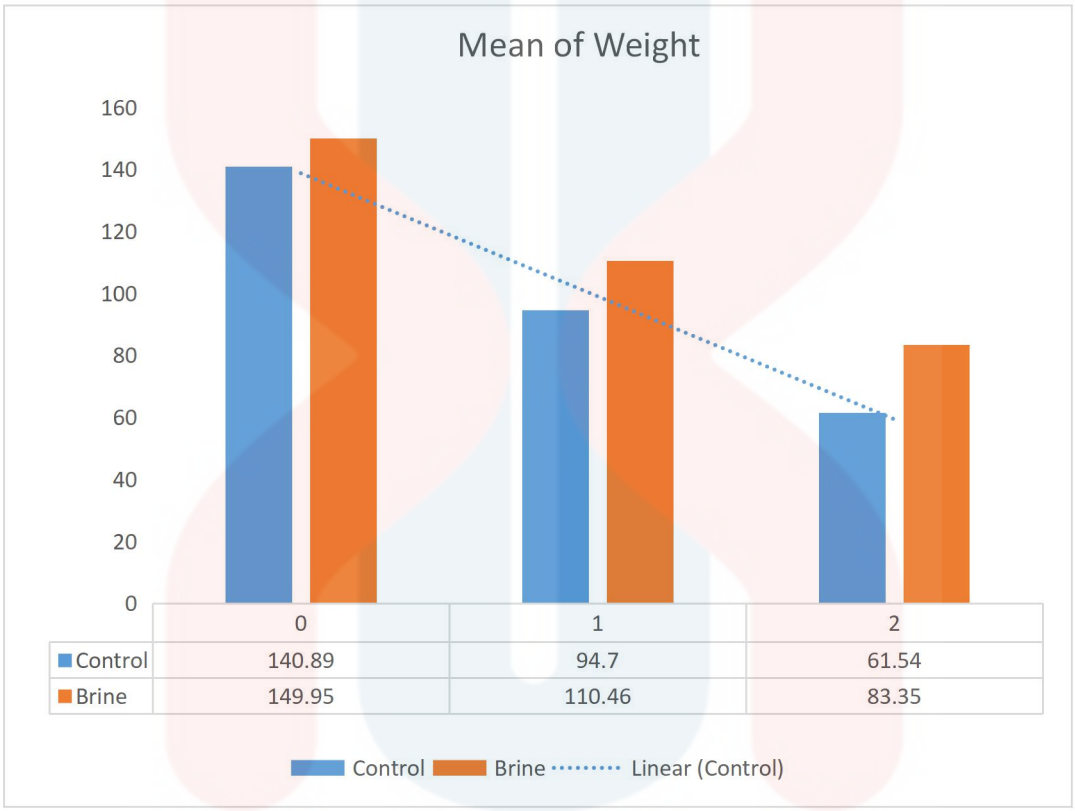


Figure 1.1: Bar chart of chicken breast in weight loss

Thus, this means that smoking time were affected the weight loss of chicken breast. The increases the smoking time, the more weight loss from the chicken breast. From the figure 1.1, the weight of chicken breast in control and brine is decrease significantly at 0 hour to 2 hours. Weight loss was effected by water loss in chicken breast and this can be confirmed by previous studies, Franco et al. (2010) stated that increasing lipid in smoked fillets,during hot and cold actually caused by dehydration or known as moisture reduction due to smoke. They also reported that weight losses due to smoking were influenced by the amount of fat and water content in fillet.

Apparently, the shrinkage in size of the chicken breast were effect by the high temperature and water loss, however, the chicken breast does not shrink at all as previous studies, Półtorak et al. (2015) stated that the use of temperature in low and continuous treatments be able to decrease the shrinkage effect due to the thermal processing. This is because the level of shrinkage was low and the denatured of the protein in chicken breast meat does change the texture of it in terms of colour. The finding by Togenberg (2005) reported that during cooking, the level of shrinkage increase with the addition of temperature and causes augment water loss and also the distinctive meat proteins are denatured and will effect change in structural of textural meat textural, the researcher also stated that cause by destruction of cell membranes, shrinkage of meat fibres, the aggregation and gel formation of myofibrillar and sarcoplasmic proteins, and shrinkage and solubilization of the connective tissue.

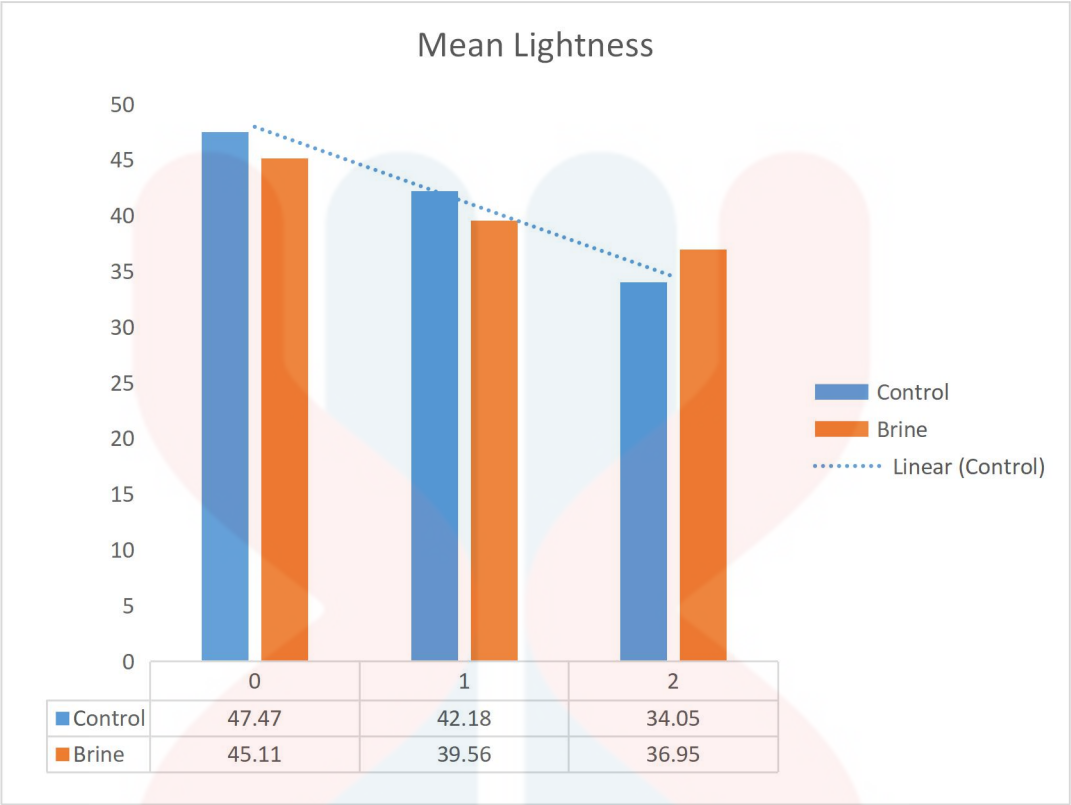
4.2 Colour

Table 1.3: Calorimeter between control and brine (Mean ± SE)

Smoke Time (hours)	Calorimeter					
	Control			Brine		
	L	a	b	L	a	b
0	47.47±1.23	7.13±0.90	11.53±0.53	45.11±0.69	2.96±0.26	8.63±0.14
1	42.18±1.66	9.82±0.32	15.90±0.47	39.56±1.79	6.86±0.48	15.59±0.94
2	34.05±3.44	10.28±0.78	14.02±1.41	36.95±2.55	9.99±0.69	15.56±0.77

Based on table 4.2, the lightness *L of chicken breast in both control and brine were had lighter turns to darker in colour which are the value of *L drop (47.47±1.23) to (34.05±3.44) and (45.11±0.69) to (36.95±2.55) respectively. The *L of the control and brine were not significantly differences which are (47.47±1.23), (42.18±1.66) and (34.05±3.44) for control and (45.11±0.69), (39.56±1.79) and (36.95±2.55) for brine.

Next, the value of redness *a of the chicken breast in control were increase from (7.13±0.90) to (10.28±0.78) while brine also turns to high value which are (2.96±0.26) to (9.99±0.69) from 0 hour to 2 hours. The redness *a between control and brine were not significantly differences which are (7.13±0.90), (9.82±0.32) and (10.28±0.78) for control and (2.96±0.26), (6.86±0.48) and (9.99±0.69) for brine. According from 0 hour to 2 hours, there was no significant different between yellowness in control and brine which are (11.53±0.53), (15.90±0.47), (14.02±1.41) and (8.63±0.14), (15.59±0.94), (15.56±0.77) respectively. Thus, there was no significant differences between the control and brine ($p > 0.05$).



	0	1	2
Control	47.47	42.18	34.05
Brine	45.11	39.56	36.95

Figure 1.2: Bar chart colour (*L- Lightness)

	0	1	2
Control	7.13	9.82	10.28
Brine	2.96	6.86	9.99

Figure 1.3: Bar chart colour (*a- Redness)

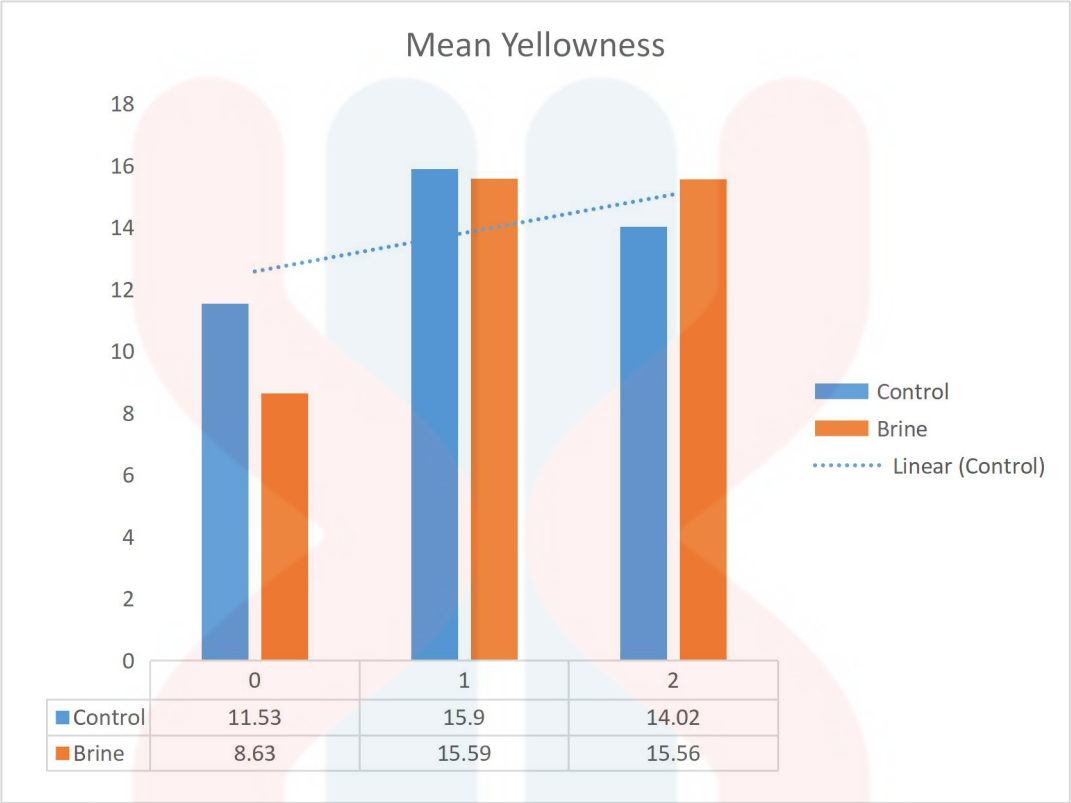


Figure 1.4: Bar chart colour (*b- Yellowness)

Based on the graph, the lightness value were decrease, increasing in redness and yellowness. However, this cannot be confirmed by previous researchers Jiménez-Colmenero et al (2003) stated that cooking will get the high value of lightness and low value in redness for meat products and another researcher, Youssef et al.(2011) reported that decreasing in L* values and increase value of b* can be explained by the reduction of myoglobin concentration in meat.

The change of chicken breast meat colour were influence by smoking temperature. This is because the preferable of consumers to select operating conditions for colour of meat. Previous studies King NJ et al. (2006), stated that dull-brown on the inside are looked as a mark of a finished cooked compared to the pink outward form was

identified as uncooked meat. Furthermore, Rinaldi et al. (2010) reported that cooked in high temperatures will improve colour and flavour and also save time of cooking but it will reduce the tenderness and juiciness. Another previous studies, García-Segovia et al. (2007) stated that in terms of colour estimation in cooked meat could gave proven facts about eating quality features.

4.3 pH

Table 1.4: pH between Control and Brine (Mean ± SE)

Smoke time(hours)	pH	
	Control	**Brine**
0	3.63±0.09	6.07±0.03
1	4.53±0.07	6.50±0.00
2	6.00±0.00	6.00±0.00

Table 4.3 shows the mean of pH of the chicken breast between control and brine within smoke time at 0, 1 and 2 hours. According to table 4.3, pH of the chicken breast in control were increase in value while chicken breast in brine were increase, from acid to alkali while brine was fluctuate which is increase then decrease in value but it still in neutral pH. The average of pH was no significant different between control and brine at 0 and 1 hour, 1 to 2 hours also 0 to 2 hours. The average between control and brine at 0 and 1 hour which are (3.63±0.09) and (6.07±0.03), (4.53±0.07) and (6.50±0.00) respectively. Next, for 1 and 2 hours between control and brine (4.53±0.07) and (6.00±0.00), (6.50±0.00) and respectively. The time between 0 to 2 hours between control and brine were (3.63±0.09) and (6.00±0.00), (4.53±0.07) and (6.00±0.00) respectively. Thus, there were not statistically significant differences ($p>0.05$) for control and brine.

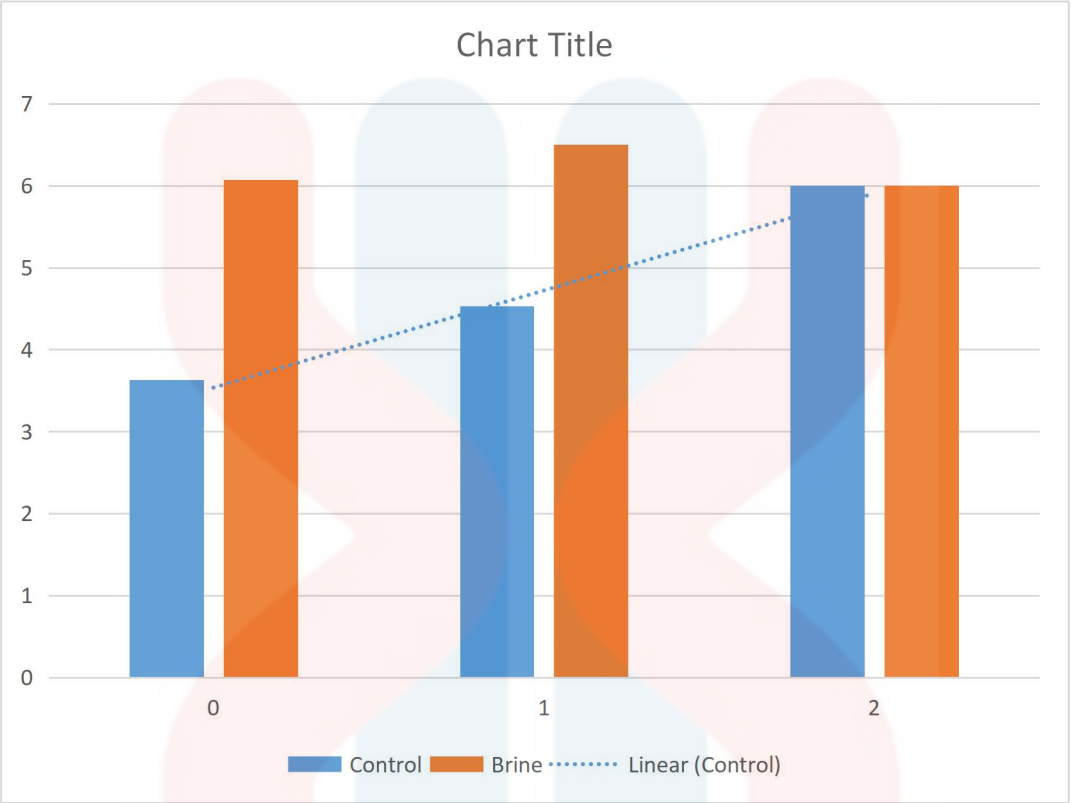


Figure 1.5: Bar chart pH

The bar graph shown that control had low value of pH compared to the brine at 0 and 1 hour, the previous studies, Nuñez-González et al. (2010) stated that by addition of alkaline (pH 7.5 and above) like sodium chloride (NaCl) and phosphates were used for brine in poultry. Another researchers Choi et al. (2009) and Kim et al. (2009) reported that heating will increase highly the marinated of cooked meat compared to the uncooked meat and Morin et al. (2002) reported similar results that pH value will increase due after thermal processing in meat products.

4.4 Moisture Loss

Table 1.5: Moisture Loss between Control and Brine (Mean ± SE)

Moisture Loss	
Control	**Brine**
42.21 ± 2.48	66.00 ± 5.16

Based on the table 4.4, the average of the moisture loss between control and brine were significantly different which are (42.21 ± 2.48) and (66.00 ± 5.16) respectively. As the weight are decrease in the moisture loss due to the decreasing in the water content of chicken breast. This is because the volume of liquid water in chicken breast removed water from muscle fibers. Basically, chicken breast meat that is cooked in a microwave exposed to air will cause water evaporate from the surface.

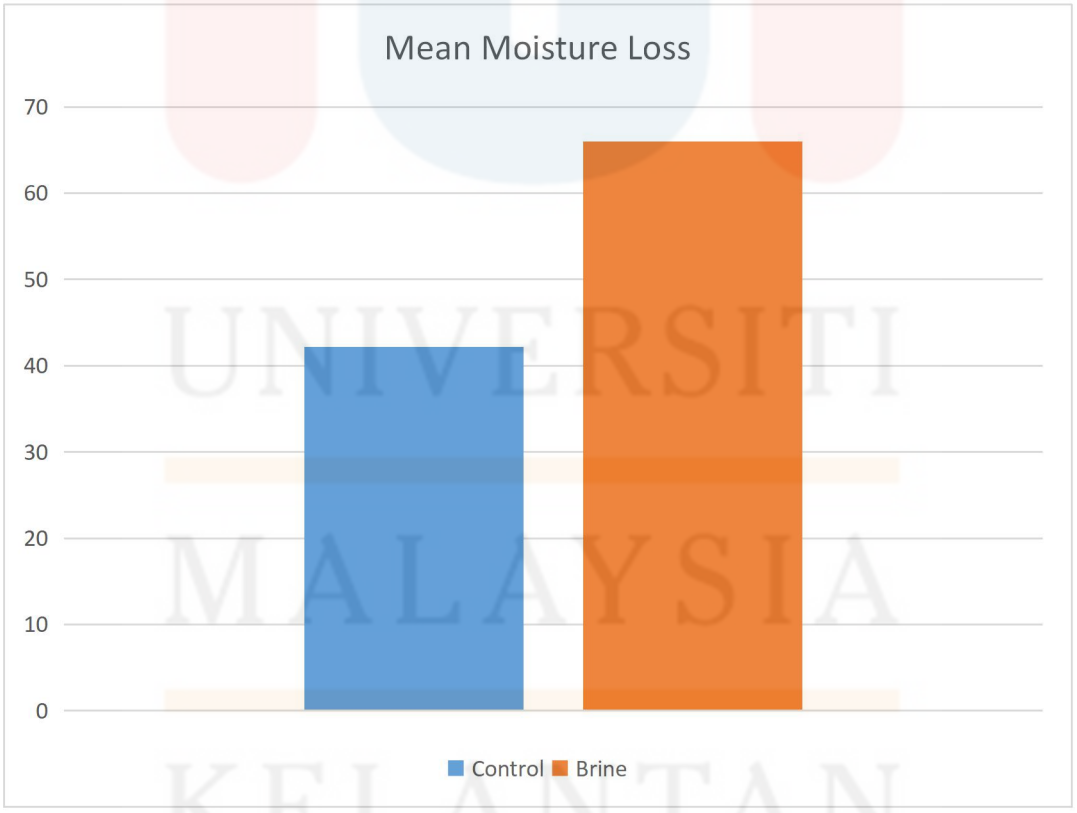


Figure 1.6: Bar chart moisture loss

Based on the graph, the moisture loss in control is more than brine which are 31.41% and 20.82% respectively. So, the moisture will loss with increasing temperature and time hence the previous studies Singh et al. (2001) stated that at all the level of water activity (a_w), the moisture content will low cause by time of cooking. Besides, Palka et al. (1999) reported that faster rate and high temperature of cooking will decreases the total cooking loss of meat and another previous studies Bailey et al. (1989) stated that the water holding capacity and total cooking loss were decreased due to the high temperature and it happened because of the myofibrillar proteins denatured during roasting, also the physical of meat will get tough due to the shrinkage and dehydration of the myofibillar proteins.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

In conclusion, the control and brine of chicken breast had different physical properties on weight loss, colour, pH and moisture loss. The weight loss between both control and brine did show the decreasing value of weight and have significant different of weight loss at 2 hours of smoking. However, average of colour of smoking time between control and brine were not significant different because the of the absorption colour of smoke was same. Next, the pH had same value at the end of the experiment due to the damage of pH meter in Food Laboratory. The average of moisture loss in chicken breast of control and brine were significantly different because the weight was decrease. Based on the present findings, further studies should be conducted in a variety of treatment conditions to optimize the combination effect of smoking on chicken breast meat.

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APPENDICES

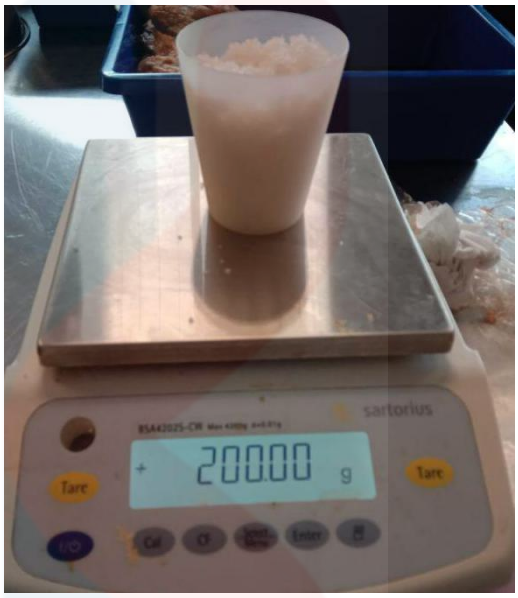

Figure 1.7: Weighing Balance

Figure 1.8: Measuring cylinder

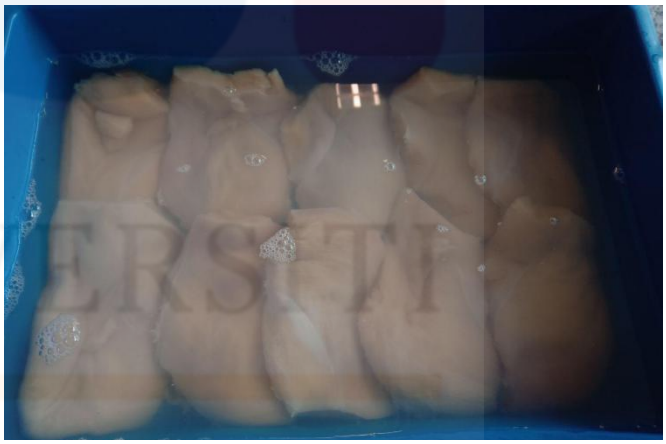

Figure 1.9: Brine chicken overnight

Figure 2.0: pH meter

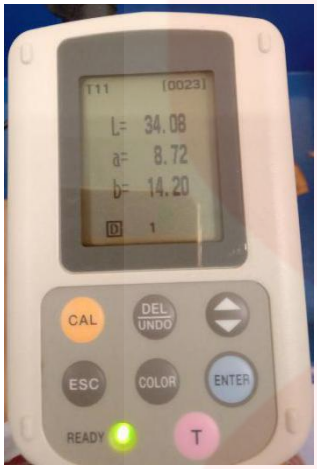

Figure 2.1: Calorimeter

Figure 2.2: Microwave

Figure 2.3: 1 hour smoke

Figure 2.4: 2 hours smoke

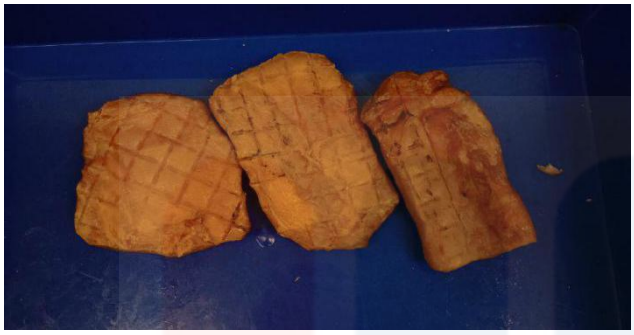

Figure 2.5: Control

Smoked Chicken (0 hour)	
Mean	140.89
Standard Error	3.96
Median	143.34
Mode	#N/A
Standard Deviation	6.86
Sample Variance	47.08
Kurtosis	#DIV/0!
Skewness	-1.40
Range	13.05
Minimum	133.14
Maximum	146.19
Sum	422.67
Count	3.00

Smoked Chicken (1 hour)	
Mean	94.70
Standard Error	2.66
Median	94.64
Mode	#N/A
Standard Deviation	4.61
Sample Variance	21.25
Kurtosis	#DIV/0!
Skewness	0.06
Range	9.22
Minimum	90.12
Maximum	99.34
Sum	284.10
Count	3.00

Smoked Chicken (2 hours)	
Mean	61.54
Standard Error	2.62
Median	62.75
Mode	#N/A
Standard Deviation	4.54
Sample Variance	20.59
Kurtosis	#DIV/0!
Skewness	-1.11
Range	8.83
Minimum	56.52
Maximum	65.35
Sum	184.62
Count	3.00

Table 1.6: Descriptive statistic of control (Weight Loss)

Smoked Chicken using Brine (0 hour)	
Mean	149.95
Standard Error	7.74
Median	142.97
Mode	#N/A
Standard Deviation	13.41
Sample Variance	179.91
Kurtosis	#DIV/0!
Skewness	1.71
Range	23.95
Minimum	141.46
Maximum	165.41
Sum	449.84
Count	3.00

Smoked Chicken using Brine (1 hour)	
Mean	110.46
Standard Error	5.61
Median	106.04
Mode	#N/A
Standard Deviation	9.72
Sample Variance	94.46
Kurtosis	#DIV/0!
Skewness	1.62
Range	17.87
Minimum	103.73
Maximum	121.60
Sum	331.37
Count	3.00

Smoked Chicken using Brine (2 hours)	
Mean	83.35
Standard Error	5.05
Median	79.51
Mode	#N/A
Standard Deviation	8.75
Sample Variance	76.51
Kurtosis	#DIV/0!
Skewness	1.59
Range	16.18
Minimum	77.18
Maximum	93.36
Sum	250.05
Count	3.00

Table 1.7: Descriptive statistic of brine (Weight Loss)

	Control	*Brine*
Mean	99.04	114.59
Variance	1588.25	1121.66
Observations	3.00	3.00
Pearson Correlation	1.00	
Hypothesized Mean Difference	0.00	
df	2.00	
t Stat	(4.22)	
P(T<=t) one-tail	0.03	
t Critical one-tail	2.92	
P(T<=t) two-tail	0.05	
t Critical two-tail	4.30	

	0 H	*1 H*
Mean	145.42	102.58
Variance	41.04	124.19
Observations	2.00	2.00
Pearson Corre	1.00	
Hypothesized	0.00	
df	1.00	
t Stat	12.79	
P(T<=t) one-ta	0.02	
t Critical one-t	6.31	
P(T<=t) two-ta	0.05	
t Critical two-t	12.71	

	1 H	*2 H*
Mean	102.58	72.45
Variance	124.19	237.84
Observations	2.00	2.00
Pearson Correlation	1.00	
Hypothesized Mean	0.00	
df	1.00	
t Stat	9.96	
P(T<=t) one-tail	0.03	
t Critical one-tail	6.31	
P(T<=t) two-tail	0.06	
t Critical two-tail	12.71	

Table1.8: t-Test: Paired Two Sample for Means (Weight Loss)

noked Chicken (0 hou	
Mean	47.47
Standard I	1.23
Median	46.60
Mode	#N/A
Standard I	2.13
Sample Vi	4.53
Kurtosis	#DIV/0!
Skewness	1.54
Range	3.98
Minimum	45.92
Maximum	49.90
Sum	142.42
Count	3.00

noked Chicken (1 hou	
Mean	42.18
Standard I	1.66
Median	43.54
Mode	#N/A
Standard I	2.87
Sample Vi	8.23
Kurtosis	#DIV/0!
Skewness	-1.66
Range	5.23
Minimum	38.88
Maximum	44.11
Sum	126.53
Count	3.00

oked Chicken (2 hou	
Mean	34.05
Standard I	3.44
Median	34.08
Mode	#N/A
Standard I	5.96
Sample Vi	35.52
Kurtosis	#DIV/0!
Skewness	-0.03
Range	11.92
Minimum	28.07
Maximum	39.99
Sum	102.14
Count	3.00

noked Chicken (0 hou	
Mean	7.13
Standard I	0.90
Median	6.35
Mode	#N/A
Standard I	1.57
Sample Vi	2.45
Kurtosis	#DIV/0!
Skewness	1.68
Range	2.83
Minimum	6.10
Maximum	8.93
Sum	21.38
Count	3.00

noked Chicken (1 hou	
Mean	9.82
Standard I	0.32
Median	9.90
Mode	#N/A
Standard I	0.55
Sample Vi	0.30
Kurtosis	#DIV/0!
Skewness	-0.62
Range	1.09
Minimum	9.24
Maximum	10.33
Sum	29.47
Count	3.00

oked Chicken (2 hou	
Mean	10.28
Standard I	0.78
Median	10.99
Mode	#N/A
Standard I	1.35
Sample Vi	1.83
Kurtosis	#DIV/0!
Skewness	-1.71
Range	2.41
Minimum	8.72
Maximum	11.13
Sum	30.84
Count	3.00

noked Chicken (0 hou	
Mean	11.53
Standard I	0.53
Median	11.59
Mode	#N/A
Standard I	0.93
Sample Vi	0.86
Kurtosis	#DIV/0!
Skewness	-0.27
Range	1.85
Minimum	10.58
Maximum	12.43
Sum	34.60
Count	3.00

noked Chicken (1 hou	
Mean	15.90
Standard I	0.47
Median	15.89
Mode	#N/A
Standard I	0.82
Sample Vi	0.67
Kurtosis	#DIV/0!
Skewness	0.07
Range	1.64
Minimum	15.09
Maximum	16.73
Sum	47.71
Count	3.00

oked Chicken (2 hou	
Mean	14.02
Standard I	1.41
Median	14.20
Mode	#N/A
Standard I	2.45
Sample Vi	6.00
Kurtosis	#DIV/0!
Skewness	-0.32
Range	4.89
Minimum	11.49
Maximum	16.38
Sum	42.07
Count	3.00

Table 1.9: Descriptive statistic of control (Colour)

Smoked Chicken (0 hour)	
Mean	45.11
Standard Er	0.69
Median	44.85
Mode	#N/A
Standard De	1.20
Sample Vari	1.43
Kurtosis	#DIV/0!
Skewness	0.92
Range	2.35
Minimum	44.06
Maximum	46.41
Sum	135.32
Count	3.00

oked Chicken (1 hou	
Mean	39.56
Standard I	1.79
Median	40.23
Mode	#N/A
Standard I	3.09
Sample V	9.57
Kurtosis	#DIV/0!
Skewness	-0.92
Range	6.08
Minimum	36.19
Maximum	42.27
Sum	118.69
Count	3.00

oked Chicken (2 hou	
Mean	36.95
Standard I	2.55
Median	37.69
Mode	#N/A
Standard I	4.41
Sample V	19.47
Kurtosis	#DIV/0!
Skewness	-0.74
Range	8.73
Minimum	32.21
Maximum	40.94
Sum	110.84
Count	3.00

Smoked Chicken (0 hour)	
Mean	2.96
Standard Er	0.26
Median	2.80
Mode	#N/A
Standard De	0.45
Sample Vari	0.20
Kurtosis	#DIV/0!
Skewness	1.39
Range	0.86
Minimum	2.61
Maximum	3.47
Sum	8.88
Count	3.00

oked Chicken (1 hou	
Mean	6.86
Standard I	0.48
Median	6.66
Mode	#N/A
Standard I	0.83
Sample V	0.69
Kurtosis	#DIV/0!
Skewness	1.02
Range	1.62
Minimum	6.15
Maximum	7.77
Sum	20.58
Count	3.00

oked Chicken (2 hou	
Mean	9.99
Standard I	0.69
Median	9.89
Mode	#N/A
Standard I	1.19
Sample V	1.42
Kurtosis	#DIV/0!
Skewness	0.37
Range	2.38
Minimum	8.85
Maximum	11.23
Sum	29.97
Count	3.00

Smoked Chicken (0 hour)	
Mean	8.63
Standard Er	0.14
Median	8.63
Mode	#N/A
Standard De	0.24
Sample Vari	0.06
Kurtosis	#DIV/0!
Skewness	-0.06
Range	0.47
Minimum	8.39
Maximum	8.86
Sum	25.88
Count	3.00

oked Chicken (1 hou	
Mean	15.59
Standard I	0.94
Median	15.91
Mode	#N/A
Standard I	1.63
Sample V	2.67
Kurtosis	#DIV/0!
Skewness	-0.85
Range	3.22
Minimum	13.82
Maximum	17.04
Sum	46.77
Count	3.00

oked Chicken (2 hou	
Mean	15.65
Standard I	0.77
Median	15.85
Mode	#N/A
Standard I	1.33
Sample V	1.77
Kurtosis	#DIV/0!
Skewness	-0.66
Range	2.64
Minimum	14.23
Maximum	16.87
Sum	46.95
Count	3.00

Table 2.0: Descriptive statistic for brine (Colour)

	L	*L*
Mean	41.23	40.54
Variance	45.70	17.37
Observatio	3.00	3.00
Pearson Cc	0.95	
Hypothesiz	0.00	
df	2.00	
t Stat	0.39	
P(T<=t) one	0.37	
t Critical or	2.92	
P(T<=t) two	0.74	
t Critical tw	4.30	

	a	*a*
Mean	9.08	6.60
Variance	2.90	12.40
Observatio	3.00	3.00
Pearson Co	0.95	
Hypothesiz	0.00	
df	2.00	
t Stat	2.16	
P(T<=t) one	0.08	
t Critical on	2.92	
P(T<=t) two	0.16	
t Critical tw	4.30	

	b	*b*
Mean	13.82	13.26
Variance	4.81	16.08
Observati	3.00	3.00
Pearson C	0.90	
Hypothes	0.00	
df	2.00	
t Stat	0.43	
P(T<=t) or	0.35	
t Critical c	2.92	
P(T<=t) tw	0.71	
t Critical t	4.30	

Table 2.1: t-Test: Paired Two Sample for Means (colour)

Smoked Chicken (0 hour)	
Mean	3.63
Standard Error	0.09
Median	3.60
Mode	#N/A
Standard Deviation	0.15
Sample Variance	0.02
Kurtosis	#DIV/0!
Skewness	0.94
Range	0.30
Minimum	3.50
Maximum	3.80
Sum	10.90
Count	3.00

Smoked Chicken (1 hour)	
Mean	4.53
Standard Error	0.07
Median	4.60
Mode	4.60
Standard Deviation	0.12
Sample Variance	0.01
Kurtosis	#DIV/0!
Skewness	-1.73
Range	0.20
Minimum	4.40
Maximum	4.60
Sum	13.60
Count	3.00

Smoked Chicken (2 hours)	
Mean	6.00
Standard Error	0.00
Median	6.00
Mode	6.00
Standard Deviation	0.00
Sample Variance	0.00
Kurtosis	#DIV/0!
Skewness	#DIV/0!
Range	0.00
Minimum	6.00
Maximum	6.00
Sum	18.00
Count	3.00

Table 2.2:Descriptive statistic of control (pH)

Smoked Chicken using Brine (0 hour)	
Mean	6.07
Standard Error	0.03
Median	6.10
Mode	6.10
Standard Deviation	0.06
Sample Variance	0.00
Kurtosis	#DIV/0!
Skewness	-1.73
Range	0.10
Minimum	6.00
Maximum	6.10
Sum	18.20
Count	3.00

Smoked Chicken using Brine (1 hour)	
Mean	6.50
Standard Error	0.00
Median	6.50
Mode	6.50
Standard Deviation	0.00
Sample Variance	0.00
Kurtosis	#DIV/0!
Skewness	#DIV/0!
Range	0.00
Minimum	6.50
Maximum	6.50
Sum	19.50
Count	3.00

Smoked Chicken using Brine (2 hours)	
Mean	6.00
Standard Error	0.00
Median	6.00
Mode	6.00
Standard Deviation	0.00
Sample Variance	0.00
Kurtosis	#DIV/0!
Skewness	#DIV/0!
Range	0.00
Minimum	6.00
Maximum	6.00
Sum	18.00
Count	3.00

Table 2.3: Descriptive statistic of brine (pH)

	Control	*Brine*
Mean	4.72	6.19
Variance	1.43	0.07
Observations	3.00	3.00
Pearson Correlation	(0.26)	
Hypothesized Mean Difference	0.00	
df	2.00	
t Stat	(1.97)	
P(T<=t) one-tail	0.09	
t Critical one-tail	2.92	
P(T<=t) two-tail	0.19	
t Critical two-tail	4.30	

	0 H	*1 H*
Mean	4.85	5.52
Variance	2.98	1.94
Observati	2.00	2.00
Pearson C	1.00	
Hypothes	0.00	
df	1.00	
t Stat	(2.83)	
P(T<=t) or	0.11	
t Critical c	6.31	
P(T<=t) tw	0.22	
t Critical t	12.71	

	0 H	*2 H*
Mean	4.85	6.00
Variance	2.98	0.00
Observati	2.00	2.00
Pearson C	#DIV/0!	
Hypothes	0.00	
df	1.00	
t Stat	(0.94)	
P(T<=t) or	0.26	
t Critical c	6.31	
P(T<=t) tw	0.52	
t Critical t	12.71	

	0 H	*2 H*
Mean	4.85	6.00
Variance	2.98	0.00
Observati	2.00	2.00
Pearson C	#DIV/0!	
Hypothes	0.00	
df	1.00	
t Stat	(0.94)	
P(T<=t) or	0.26	
t Critical c	6.31	
P(T<=t) tw	0.52	
t Critical t	12.71	

Table 2.4: t-Test: Paired Two Sample for Means (pH)

Moisture Loss (g)	
Mean	42.21
Standard I	2.48
Median	42.78
Mode	#N/A
Standard I	4.30
Sample Vi	18.52
Kurtosis	#DIV/0!
Skewness	-0.59
Range	8.55
	37.65
	46.20
	126.63
	3.00

Moisture Loss (g)	
Mean	66.00
Standard I	5.16
Median	61.75
Mode	#N/A
Standard I	8.93
Sample Vi	79.83
Kurtosis	#DIV/0!
Skewness	1.66
Range	16.28
Minimum	59.99
Maximum	76.27
Sum	198.01
Count	3.00

	Control	*Brine*
Mean	51.88	74.68
Variance	186.82	150.51
Observations	2.00	2.00
Pearson Correlation	1.00	
Hypothesized Mean Differer	0.00	
df	1.00	
t Stat	(23.03)	
P(T<=t) one-tail	0.01	
t Critical one-tail	6.31	
P(T<=t) two-tail	0.03	
t Critical two-tail	12.71	

	2 H	*Vlicrowave*
Mean	72.45	54.11
Variance	237.84	282.98
Observati	2.00	2.00
Pearson C	1.00	
Hypothes	0.00	
df	1.00	
t Stat	18.53	
P(T<=t) or	0.02	
t Critical c	6.31	
P(T<=t) tw	0.03	
t Critical t	12.71	

Table 2.5: Descriptive statistic and t-Test: Paired Two Sample for Means (Moisture Loss)