Effect of Cooking Methods of Chicken Meat Mixed with Macaroni on Physicochemical Properties and Sensory Acceptability During Frozen Storage.

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DECLARATION

I hereby declare that the work embodied in this report is the result of the original research and has not been submitted for a higher degree to any universities or institutions.

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I certify that the report of this final year project entitled "Effect of Cooking Method of Chicken Meat Mixed with Macaroni on Physicochemical Properties and Sensory Acceptability During Frozen Storage" by Alifah Ilyana binti Azian matric number F15A0010 has been examined and all the correction recommended by examiners have been done for the degree of Bachelor of Applied Science (Animal Husbandry Science) with Honours, Faculty of Agro-Based Industry, Universiti Malaysia Kelantan.

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LIST OF ABBREVIATIONS AND SYMBOL

g	Gram
kg	Kilogram
cm	Centimetre
min	Minutes
mL	Millilitre
^{0}C	Degree Celsius
mm/s	Millimetre per second
H_2SO_4	Sulphuric Acid
NaOH	Sodium Hydroxide
H_3BO_3	Boric Acid
HCl	Hydrochloric Acid
mm	Millimetre
mJ	Mega Joule
±	Plus Minus
L*	Lightness
a*	Redness
b*	Yellowness
≥	Equal / More Than
≤	Equal / Less Than
%	Percentage
x	Times

Effect of Cooking Method on Chicken Meat Mixed with Macaroni on Physicochemical Properties and Sensory Acceptability during Frozen Storage.

ABSTRACT

Different cooking process leads to change in the chemical composition and physical structure of foods. Frozen food industry has increased in the market and is important in human's diet. Frozen food has also been cooked by a cooking method based on the preference of the household. In this study, different cooking method had been applied to chicken meat and macaroni. The colour, textural properties and sensory acceptability on different cooking method have been studied while the nutritional composition of chicken and macaroni was accessed according to AOAC. The results showed that air fry method for chicken was the highest for *L** and *b** value (62.82 ± 1.71^{a}), (25.75 ± 0.77^{b}) respectively while for macaroni the oven method was highest in *L** and *a** value of 61.24 ± 2.18^{a} and 4.26 ± 1.95^{a} respectively. For texture properties, of chicken and macaroni, there was slight difference among cooking method in hardness with the range 5074.33 – 5253.33, springiness and chewiness of chicken and macaroni have the highest value in air fry at 9.37 ± 0.81^{a} and $10.38 \pm 0.17^{b,}$ 349.33 ± 63.64 and 460.80 ± 58.23^{a} respectively. For nutritional composition of chicken and macaroni showed been cooked by air fry is the highest in moisture (72.93 ± 0.01^{a}, 58.43 ± 0.06^{a}), protein (35.69 ± 0.04^{a}, 7.20 ± 0.04^{a}) and ash (5.70 ± 0.01^{a}, 0.51 ± 0.01^{a}) while lowest in fat (1.97 ± 0.014^{c}, 0.02 ± 0.01^{c}). For sensory acceptability, air fry method showed the highest for five out six attributes Based on a good and beneficial properties, air fry method may be used as the main cooking method in order for the food to be healthier and more nutrition after being cooked.

Keywords: Cooking Method, colour, frozen, nutritional composition, sensory acceptability, texture.

Kesan Pelbagai Kaedah Masakan Terhadap Daging Ayam Yang Dicampur dengan Makaroni pada Sifat Fizikokimia dan Ketulusan Sensori semasa Penyimpana Beku.

ABSTRAK

Proses memasak yang berbeza membawa perubahan dalam komposisi kimia dan struktur fizikal makanan. Industri makanan beku telah meningkat di pasaran dan penting dalam diet manusia. Makanan beku dimasak dengan kaedah memasak yang dipilih oleh isi rumah Dalam kajian ini, kaedah memasak yang berbeza telah digunakan terhadap daging ayam dan makaroni. Warna, sifat tekstur dan kebolehterimaan deria pada kaedah memasak yang berbeza telah dikaji sementara komposisi pemakanan ayam dan makaroni telah diakses mengikut AOAC. Keputusan menunjukkan bahawa kaedah menggoreng menggunakan udara bagi ayam adalah tertinggi untuk nilai *L* * dan *b* * (62.82 ± 1.71^{a}), (25.75 ± 0.77^{b}) manakala untuk makaroni kaedah ketuhar adalah tertinggi dalam *L* * dan nilai *a** 61.24 ± 2.18^{a} dan 4.26 ± 1.95^{a}. Bagi sifat tekstur, ayam dan makaroni terdapat sedikit perbezaan di antara cara memasak dengan kekerasan dengan jarak 5074.33 - 5253.33, kenyal dan kunyahan ayam dan makaroni mempunyai nilai tertinggi dalam penggoreng udara pada 9.37 ± 0.81^{a} dan 10.38 ± 0.17^{b}, 349.33 ± 63.64 dan 460.80 ± 58.23^{a}. Untuk komposisi nutrisi ayam dan makaroni yang telah dimasak dengan penggoreng udara mempunyai kelembapan tertinggi (72.93 ± 0.01^{a}, 58.43 ± 0.06^{a}), protein (35.69 ± 0.04^{a}, 7.20 ± 0.04^{a}) dan abu (5.70 ± 0.01^{a}, 0.51 ± 0.01^{a}) manakala lemak adalah yang terendah (1.97 ± 0.014c, 0.02 ± 0.01^{c}). Untuk kebolehterimaan deria, kaedah penggoreng udara menunjukkan yang paling tinggi untuk lima sifat daripada enam. Berdasarkan nilai-nilai yang ideal dan berfaedah, kaedah penggoreng udara boleh digunakan sebagai kaedah memasak utama agar makanan menjadi sihat dan mengandungi lebih banyak nutrisi selepas dimasak.

Kata kunci: Beku, kaedah masakan, kebolehterimaan deria, komposisi makanan, tekstur, warna

CHAPTER 1

INTRODUCTION

1.1 Background Study

The frozen food industry has increased in the market and is important in the human diet. Horace and Paul (1960) reported that frozen food is increasingly important things in the American diet. The annual per capita consumption of frozen food has risen from 2 kilograms to nearly 14 kilograms. Even though the frozen foods are not fully free from potentially hazardous microorganisms, the safety records that frozen food held were favourable with other preserved food.

In terms of frozen food nutritional values, it will retain the nutritional value of fresh foods during the freezing process. The techniques used for frozen food enable this type of food to preserve its colour and flavour of food and also helps to protect the natural vitamin and minerals which only the frozen food method can be done. Frozen food has been cooked by a cooking method based on the preference of the household once it arrived on the kitchen counter. Usually cooking method favourable by household to

cooked their frozen food will be deep fry method. The different cooking method resulted in different texture, nutritional value, taste and flavour of food. Ibrahim, El-Ghorab, El-Massry and Osman (2012) stated that the reactions that occur from microwave food are different from the one that prepared by oven and frying. The reaction that occurs in the oven and frying process differs with microwave. The results of this experiment show that food that undergoes the microwave process contributes to the lack of flavour and colour.

Chemical composition and physical structure of the food can be changed in the cooking process (Zhang & Hamauzu, 2004). The changes that occur depend on the cooking method, temperature, pressure and time. Nutritional value, sensorial characteristic and the time consumption is some of the factors that need to consider when selected which cooking method that need to be used (Baysal, 1986; Sağun, Testereci, Yörük, & Ekici, 1997).

Cooking methods also can lead to minerals and vitamin loss and changes in fatty acid composition which is depending on the lipid oxidation (Rodriguez-Estrada, Penazzi, Caboni, Bertacco & Lerker, 1997). Mehmet, Ulas, Esra and *et.al* (2017) showed that the colour of green peas slightly changes lower in the traditional cooking method compared to cook vide methods. In terms of antioxidant activity, total phenolic and vitamin C analyses reflected that less harm to green peas in cook videos methods compared to the sous-vide and traditional cooking method. It shows that the different cooking method gives different effectiveness towards the different type of food sample.

1.2 Problem Statements:

Malaysia is the country that well-know of its variety of food which from fine dining meals to a deep fried snack from street hawkers, food in Malaysia is often high in cholesterol and fat with copious amounts of sugar and salt (Reuters, 2007). Obesity in Malaysia had been increased by 43% from the year 2006 according to Malaysia National Health and Morbidity Survey. Thus, the different cooking method affects the nutrients of the food. Based on research that conduct by Ismail et. al (2002), one of the factors that contributes to obesity in Malaysia is the way they prepared and cooked the food and mostly every household tends to fry their food by using a lot of oils. Different cooking method can change the nutrient composition of the food (Slavin, J, Jacobs & Marquat, 2001). Determining the appropriate cooking method can result in nutritional value and the sensory texture of the food. The appropriate cooking method of food can help Malaysian to consume healthier and nutritional food.

1.3 Objective:

1. To determine the texture, colour, and chemical analysis of chicken meat mixed with macaroni prepared by using the different cooking method
2. To determine the sensory evaluation of the chicken meat mixed with macaroni prepared by using the different cooking method

1.4 Hypothesis

H_o: Nutritional value, colour, sensory and texture of the chicken meat mixed with macaroni will be affected by different cooking method

H_1: Different cooking method of chicken meat mixed with macaroni will not affect the nutritional value, colour, sensory and texture.

H_o: The shelf life of the frozen chicken meat mixed with macaroni product will be longer than 2 weeks

H_1: The shelf life of the frozen chicken meat mixed with the product will not be longer than 2 weeks.

1.5 Scope of study

The scope of this study includes determining colour, texture properties and the proximate composition of the chicken and macaroni that cooked by different method. Also the total plate count of the frozen storage of the samosa. Lastly, the sensory acceptability of the samosa with different cooking method was also studied.

1.6 Significance of study:

The finding of this study will contribute to which cooking method is the best in term of the colour texture and nutritional composition for a food product. Besides, with this

study, people can be introduced to a new cooking method that has more nutritional value than others to prevent increasing the obesity problem in Malaysia.

CHAPTER 2

LITERATURE REVIEW

2.1 Frozen Industry

Frozen or freezing food is a process of preserving food starts from the preparation of the food until the food been eaten. Earlier time, farmers, fishermen, and trappers would have preserved their food and produced in the unheated building during the winter season. Freezing food slows down decomposition by turning residual moisture into ice, inhibiting the growth of most bacterial species. (Parker.2010).

Parker (2010) states that the preserving the food in the domestic kitchen during the 20th and 21st centuries was achieved using the household freezers. The household had been advised by Beth Hart, (Sainsbury's head of product technology for fresh and frozen) to freeze the food on the day of purchase. There was a campaign that held by UK's Waste and Resources Action Programme, been promotes advising the freezing food as soon as possible up to products used by date. The frozen product is the product that does not require any added preservative because of the microorganisms do not.

grow when the temperature of the food is below -9.5 °C. This temperature is sufficient on its own in preventing the food spoilage. For the long-term preservation of food at a lower temperature a carboxymethylcellulose (CMC) a tasteless and odourless stabilizer normally will be added to frozen food because it does not adulterate the quality of the products (Parker,2010).

2 .2 Trends or Demand for Frozen Food

The frozen food industry has dominated the food industry at the global market level. As reported by Allied Market Research (2015) the retail customers of frozen food include individuals and household whereas the business customers include hotel chains, fast food outlets, caterers and another business buyer.

Its been reported that frozen food market is expected to grow at a compound annual growth rate (CAGR) of 14% during the time from 2015 to 2020. The growth of the frozen food market has been driven by the growing demand and consumption of frozen food in a developing market such as India, China and other Asian countries. The increase in demand market of frozen food because of the change in lifestyle and food habits. Moreover, with the increasing number or large retails number chains including hypermarket and supermarkets has increased the demand for frozen food in developing Asian countries (Allied Market Research, 2015).

Allied Market Research (2015) stated, increasing online purchase of staple is also a major factor of increasing the frozen food market. Staple food defined as food items that can be stored easily and eaten throughout the year. The purchase of staple food online has been gaining its popularity across the developing nation. This is because of the

lifestyle of people nowadays that lead to a busy life and always working. By ordering online it can consume less of their time. That is lead to the increasing the frozen food demand in the market.

2.3 Chicken Meat

Chicken is the most common known species among the poultry animals. Chicken also is the most consume by people around the world among the poultry kinds. Static by Agriculture and Agri-Food Canada (AAFC) 2018 showed that chicken is the popular choice among Canadian for 72 % that is leaner and lower of fat. The choices made by Canadians that mostly are watching their weight as the main reason why they choose chicken meat.

For the past several years, chicken meat especially chicken breast has been benefited to the consumer that watching their health and concern about the fat intake. The fact that it is cheaper, high in nutritional facts, sensory and the lack of cultural or religious obstacle makes the chicken are highly consumed by people compared to other types of meat in the market (Larry, 2002; Valceshini, 2006).

2.4 Macaroni

Macaroni is one of the common dry pasta that been consumed by people besides spaghetti, linguine and etc. Macaroni is a pasta looks like a narrow tube and usually made with durum wheat. It is also being referred to as elbow macaroni. According to Manthey and Dick (2012) pasta products such as macaroni and etc. have become an important component of the meals from various countries. Wide consumption of pasta for several countries because of the nutritious and it more convenient to prepared and cooked

Table 2.3 Average yearly per capita consumption in selected countries.

Country	Per capita of consumption (kg)
Italy	28.0
Venezuela	12.7
Switzerland	9.1
USA	9.0
Russia	7.0
France	7.0
Greece	6.6
Canada	6.3
Germany	5.0
Spain	4.0
UK	2.0
Japan	1.8
China	0.8

Even though nutritional content of pasta can vary widely by depending on how or what kind of ingredients that have been used in its preparation process also what it cooked with. Normally, the typical of 140 g serving cooked macaroni provides approximately 6 g of protein, 40 g of carbohydrates and less than 1 g of fat per serving. With all the high nutritional value in one serving is the reason why the consumption of the pasta getting increase throughout the years.

2.5 Cooking Method for food

Food quality can be affected by different of the cooking method. Bernhardt and Schlich (2005) reported the influence of different domestic cooking methods on all-trans and cis-b-carotene as well as the a-tocopherol content in fresh and frozen broccoli and sweet pepper. The result showed that the fresh broccoli releases all trans-b-carotene and a-tocopherol with all cooking method while in the frozen broccoli while in frozen broccoli there were slight changes. The frozen broccoli losses of all-trans-b-carotene because of the blanching process that disturbed the cell membrane of the vegetables.

2.5.1 Deep-fat Fry

The deep-fat fry method can be defined as the process of drying and cooking through contact with hot oil. (Sahin, Sastry, S. K. & Bayindirili, L.,1999). The deep-fat fry method is one of the oldest methods that had been used and it is one of the popular method for food preparations. In the United States of America, the economy of

commercial deep-fat frying industry has been estimated around $83 billion of value which at least it is a twice the amount of the world (Pedreshi, Moyano, Kaack, & Granby, 2005).

Stated by Choe and Min (2007), frying is a process where it is involved the immersing of the food into hot oil with contact among oil, air and food at a high temperature of 150 ^{0}C to 190 ^{0}C. The desirable and unique quality of deep-fat fry food is when the heat becomes a simultaneous and mass transfer of oil, food and air during the process. Frying oil react as a heat transfer medium and it also contributes to the texture and flavour of fried food. Along with that, the fat also migrates into the food which providing nutrients and flavour to the food (Liu-ping, Min & Arun, 2005). Deep-fat fried food become popular among the consumers may due to desirable flavour, colour and crispy texture (Boskou, Salta, Chiou, Troullidou, & Andrikopolous, 2006).

2.5.2 Baked

The baking process is one of the ancient processes that remain as an important method in the food industry. Baking is a process that used heated air to alter the quality of the foods. The baking process is like dehydration and smoking. Common usage of the baking process usually applied to flour-based foods product or fruits.

Reported by Xue, Lefort and Walker (2004), the oven that used for the baking process was vanned by including different number of perlite and water dummy loads during baking. It also states that the increased in oven humidity is resulted because in the products it has higher the yield, greater volume or spread, lighter colour and reduced firmness. The humidity of the products affects the colour, baking speed, crust and crumb

texture which lead to the final product that moisture but if its optimal humidity the levels are not well established.

Baking methods using oven is traditionally being controlled by time and temperature. The advance of the oven has added the heat transfer coefficient consideration and airflow speed control for the new system. (Kriemes, 1994)

Baked food product includes several different categories, which is based principally of their moisture, fat, and sugar contents. Each of the components requires different baking conditions in order to produce the best good baked products.

2.5.3 Air-Frying

Hot air frying or air-frying is a new technique that has been introduced to industry to get the fried products through direct contact between an external emulsion of oil droplets in hot air and the product into the frying chamber. This process shows how the products are being constantly in motion to promote homogenous contact between two phases.

The process ensures the product become dehydrated and the typical crust of the fried product will appear. Moreover, the amount of oil that been used in this process is significantly lower than in deep-fat frying method, which it gives the result of the air-frying product produce a very low-fat product (Ana , Ángel , Maria & Ana , 2012

Shaker and M.Arafat (2016) stated that the air frying method indicated that the moisture content and oil uptake in fried potato strips by air frying process were significantly lower than fried potato strips that undergoing a deep-fat frying process. Plus,

the changes in some physico-chemical properties (free fatty acids, peroxide value, polar, polymer and oxidized fatty acids contents) of oil from fried potato were significantly higher in deep-fat frying than air-frying method. Moreover, organoleptic attributes of the fried potato by the air-frying methods have been surpassed on fried potato strips for deep-fat frying methods. The paper believed that the air-frying methods are a comfort and suitable methods to be used for the frying process and to produce healthy fried foods for the consumer to consume rather than deep-fat frying.

2.6 Shelf Life of Food

The demanding of the high quality of food is increasing occasionally and have corresponding expectations that the high quality will be maintained at a high level during the period between purchase and consumption. In the UK, the date coding to be used is determined by the total life of the product for microbiologically highly perishable food. In general, the microbiological changes of primary importance for short-life products and chemical along with the sensory changes for medium to long life products (McGinn, 1982).

Kilcast and Subramaniam (n.d) state that, there are several intrinsic factors that influence the shelf life of the food. The factors are including water activity, availability of oxygen, nutrients, redox potential, natural microflora and surviving microbiological counts also the uses of natural biochemistry of the product formulation and the uses of preservatives in product formulation.

Otremba, Dikeman and Boyle (1999) reported the frozen ostrich meat is being refrigerated storage up to 21 days shows that the sensorial evaluated colour showed an increase in darkness over time. The percentage of browning also increased by 28 days. Sensory aroma also changed over time with unacceptable aroma occurring by 14 days. So, the results of the experiment are the frozen ostrich meat that stored under refrigerated should be used within 10 days.

2.7 Total Plate Count

Total plate count is total counts of bacteria that grow aerobically are made in order to determine the quality of foods. The Aerobic Plate Count (APC) methods had been established for many years in terms of performing the viable cell count of foods. The advantage of using this method include its widespread acceptance, relative ease of operation and the methods is decades of experience by most microbiologist (Association of Official Analytical Chemists {AOAC}, 1984).

Jay (2002) reported that the aerobic plate count is a method that widely used to assess the microbial load of fresh meat and poultry. APC used for determining the overall product quality and handling storage history and also providing information regarding on product safety and shelf life.

Nychas *et.al* (2007) reported that the spoilage of the processed meat is mainly caused by microbial growth and it can be determined by the total plate count method. The spoilage that occurs is only caused by a small fraction of the initial bacteria. These bacteria occur had reduced the meat shelf life

CHAPTER 3

MATERIALS AND METHODS

3.1 Materials

3.1.1 Raw Materials

Raw materials used in this experiment can be found at the local market which is Pantai Timur that located at Bukit Bunga. The raw materials were 0.5 kg of chicken breast, 0.5 kg of carrot, 0.5 kg of Kimball macaroni, 1 packet of KG Pastry popiah skin and 1 kg of Seri Murni pure vegetable oil.

3.1.2 Utensils

Equipment that used in this experiment were aluminium foil, cutting board, knife, stove, pot, striking loop, pipette, petri dish with agar, beaker and bunsen burner.

3.1.3 Instruments

NB-H3800 oven (Panasonic Sdn.Bhd., Malaysia), NN-ST34HMMPQ microwave (Panasonic Sdn. Bhd. Malaysia) DFT6000 deep-fryer (Fic Kitchen Technology Sdn Bhd, Selangor, Malaysia) KHIND ARF22 air-frying (Khind Holding Berhad, Selangor, Malaysia), AMBI-50 incubator (Tech-Lab Scientific Sdn Bhd, Balakong, Malaysia), TA-XT2 texture analyzer (Stable Micro System, Godalming, Surrey, UK), MX-900MUSL blender (Panasonic Sdn. Bhd., Malaysia), CR-400 chromameter (Konica Minolta Sensing Americas, USA) and SES6202 Saffron Precision weighing balance (Saffron Electronic Scales, Varachha Road, Surat, Gujrat, India)

3.2 Methods

3.2.1 Sample Preparation of Chicken Meat Mixed with Macaroni

All raw ingredients were being prepared. Chicken meat and carrot were diced into a cube by 2cm x 2cm 2 cm. For macaroni, it had been boiled for 10 minutes and rinsed. The chicken meat was weighed for 10 g while macaroni and carrot were weighed 5 g for a samosa. All the ingredients were mixed together and were wrapped with popiah skin and fold into triangular shaped. The samples of chicken mixed with macaroni in a state of samosa were kept for frozen storage and some of it would undergo treatments of different cooking methods. A commercial samosa was served as a control in this experiment

Table 3.2.1. Formulation of chicken meat mixed with macaroni

Ingredients	Cooking Method		
	Deep Fry	Oven	Air Fry
Chicken (g)	10	10	10
Macaroni (g)	5	5	5
Carrot (g)	5	5	5
Popiah Skin (sheet)	1	1	1
Total	21	21	21

3.2.2 Cooking process

The samples of chicken meat mixed with macaroni were cooked by three different cooking method which was deep fry, oven and air fry method.

3.2.2.1 Deep fry method

The deep fryer was filled with the oil and heated it for 5 minutes at the temperature between 180 °C. The chicken meat mixed with macaroni was cooked for 5 minutes and then carefully removed and dried with paper towel.

3.2.2.2. Oven method

The oven was preheated at 180 ^{0}C for 15 minutes. The chicken meat mixed with macaroni were brushed with some oil and baked it for 5 minutes. After 5 minutes, the chicken and macaroni were rested on the dry rack for it to cool.

3.2.2.3 Air Fry method

The air fryer was preheating to 202 ^{0}C. The chicken meat mixed with macaroni were brushed with some oil on the surface and then cooked until the coloured turned to golden brown for 5 minutes.

3.2.3 Colour Analysis of Chicken Meat Mixed with Macaroni

The colour of chicken meat mixed with macaroni from different cooking method was determined by using chroma-meter. The samples colour value was expressed by the parameters (L^*, a^*, b^*) measured by a colorimeter (Chroma Meter CR 400, Konica Minolta, Japan). L^* indicate whiteness or brightness/darkness), a^* (redness/greenness) and b^* (yellowness/blueness) (Alhamdan et.al., 2018).

3.2.4 Texture Profile Analysis of Chicken Meat Mixed with Macaroni

Texture properties of the chicken meat mixed with macaroni of different cooking method were determined by textural profile analysis. Texture profile analysis was

performed to all samples by using Brookfield CT3 Texture Analyzer. TPA of chicken from different cooking method was carried out by compressing them with TA11/1000 (cylinder) probe. The studies were conducted at test speed 5.0mm/s, load cell 10000 g, and trigger load 5 g (Martinez *et. al*, 2003). For macaroni, it was carried out by compressing them with TA11/1000 (cylinder) probe. The studies were conducted at test speed 3.0 mm/s, load cell 5000 g and trigger load 5 g (Manthey & Dick, 2012).

3.2.5 Proximate Analysis of Chicken Meat Mixed with Macaroni

3.2.5.1 Determination of Moisture Content in Chicken Meat Mixed with Macaroni

The empty dish and lid were dried in the vacuum oven at 100 ^{0}C for 3 hours and transferred to desiccator for cooling purpose. The empty dish and lid were weighed Next, 5 g of chicken meat and macaroni was on the dish and weighed separately. The dish sample was placed in the vacuum oven and dried at 100 ^{0}C for 3 hours. After drying, both dish with partially covered the lid was transferred to the desiccator and cooled to room temperature. Both dish and dried sample were weighed and recorded (AOAC,2000). The percentage of the moisture content was calculated using the formula in Equation 1.

Moisture content (%) = $\left(\frac{(W1-W2)}{W1}\right) X\ 100$ .....Equation 1

W1 = weight (g) of the sample before drying

W2 = weight (g) of the sample after drying

3.2.5.2 Determination of Fat Content in Chicken Meat Mixed with Macaroni

All the glass apparatus was rinsed by petroleum ether and were dried in the oven at 102 °C and after removing it keep in the desiccator. Weighed 5 g each chicken and macaroni from different cooking methods and placed it on the thimble. The thimble was placed in the soxhlet extractor. A 150 ml round bottom flask was cleaned and filled with 90 ml petroleum ether. The whole setting was placed on the heating mantle and allowed the petroleum ether to boil. The extraction process was continued for 4 hours. Then, the condensing unit was removed from the extraction unit and the sample was allowed to cool down. After that, the liquid was being removed. All the solvent was collected after the distillation and heated the solvent until it dried. Then weighed the flask and recorded it (AOAC, 2000). The total percentage of fat was calculated using the formula in Equation 2.

$$\text{Crude Fat (\%)} = \frac{(w2-w1)}{P} \times 100 \quad \text{.....Equation 2}$$

Empty thimble= w1

Thimble with sample= w2

Weight of sample= P

3.2.5.3 Determination of Protein Content in Chicken Meat Mixed with Macaroni

i. Digestion

The control unit was turned on and heated at 400 ^{0}C. Chicken meat and macaroni were prepared in digestion tube. Each digestion tube contains 1 g of sample, 2 pieces of *Kjeldahl tablet* and 12 mL of concentrated Sulphuric Acid (H_2SO_4). A tube containing the chemical above without sample was prepared as blank. All the digestion tube was placed in the insert rack and moves to hot digestion block when the present temperature is reached. The insert rack was covered by placing the exhaust system on top of the rack. After that, the scrubber unit was turned on and left for one and a half hour. After the digestion process, the control unit and scrubber unit was switched off follow by lifting the exhaust system and moving the insert rack into a fume hood. The sample was left for 1 hour at room temperature before continuing with the distillation process.

ii. Distillation

The distillation unit was cleaned by operating the system for three times, 40% of NaOH was placed in the alkali tank of Gerhardt Vapodest distillation unit. Then, the digested samples were diluted with 80 mL of distilled water and 50 mL of 45% NaOH. Then, 300 mL of receiver solution was added to the receiver flask. Next, 250 mL Erienmeyer titration flask was placed on receiving platform and filled with 4% boric acid (H_3BO_3) along indicator solution. Afterwards, the flask had transferred into the receiver solution tank. The digestion tube containing diluted digest was attached to the distillation

unit and the samples were distilled for five minutes. The green colour of steam distillates was collected. Receiving flask was being removed.

iii Titration

The H_3BO_3 receiving solution was titrated with standard 0.1M HCl until yellowish coloured appeared which as the endpoint. The volume of HCl used were recorded. The formula from equation 3 was used for the determination of CP content in the sample.

$$\%\text{Nitrogen} = \frac{(T-B) \times N \times 1.4007 \times 100}{\text{Weight of sample (mg)}} \quad \text{..... Equation 3}$$

$$\%CP = \%N \times F$$

Where,

%N = Percentage of nitrogen in the sample

T = Volume of titrant used for food sample

B = Volume of titrant used for blank sample

N = Normality of HCl solution

% CP = Percentage of CP

F = Conversion factor for nitrogen to protein, 6.25

3.2.5.4 Determination of Ash Content of Chicken Meat Mixed with Macaroni

The crucible and lid were dried in the oven at 105 ^{0}C for 3 hours and will be cooled in the desiccator for 15 minutes. The empty crucible was weighed and then 1 g of chicken and macaroni will be weighed separately and added into the crucible. All the samples from the different cooking process were weighed and put in the furnace for 6 hours at 550 ^{0}C. After 6 hours, let the sample to cool and weighed and calculated using equation 4.

$$\% \text{ ASH (wet)} = \frac{(\text{wt. crucible and ash} - \text{wt. crucible}) \times 100}{(\text{wt. crucible and sample} - \text{with. crucible})} \quad \ldots\text{Equation 4}\ldots\ldots..$$

3.2.6 Total Plate Count (TPC)

The sample of chicken and macaroni were stored in frozen storage for 98 days. The samples of chicken and macaroni were taken for TPC analysis for every 14 days. The sample of chicken and macaroni were mashed and 10 g of sample was mixed with 90 ml of distilled water. From the dilution, the sample of 0.10 ml was taken by micro pipette and then spread onto the nutrient agar in a petri dish. Then, the petri dish was incubated at 32 $^{\circ}$C and observed after 48 hours.

3.2.7 Sensory Analysis of Chicken Meat Mixed with Macaroni

The sensory test was conducted to 60 respondents in Taiping with range ages around 13-85 years old. Samosa sample was placed in a cupcake paper and labelled from A to C. Respondents acceptance was measured in terms of degree of liking. The respondents were asked to taste and evaluate the attributes of the samosa on colour, aroma, crispiness, hardness, juiciness and overall acceptance for each sample. To indicate the degree of liking, the respondents evaluate on a seven-point

3.2.8 Statistical Analysis

Total plate count, colour, texture profile analysis, moisture, fat, protein, ash, and sensory evaluation were subjected to one-way ANOVA test. All the analysis was carried out in triplicate the experimental results were expressed as a mean ± standard deviation with a statistical significance level $p \leq 0.05$ by using SPSS statistical software with post-hoc Tukey and Duncan.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Colour Properties of Chicken Meat Mixed with Macaroni

4.1.1. Lightness Values of Chicken Meat Mixed with Macaroni Prepared by Using Different Cooking Methods

Table 4.1.1 Lightness (*L**) value of chicken meat mixed with macaroni prepared by using the different cooking method.

Cooking Method	**Deep Fry**	**Oven**	**Air Fry**
	Mean ± SD	**Mean ± SD**	**Mean ± SD**
Sample			
Commercial	43.33 ± 0.89^{c}	63.14 ± 0.42^{b}	65.12 ± 0.49^{a}
Chicken Meat and Macaroni	42.77 ± 0.82^{c}	63.99 ± 0.98^{b}	66.13 ± 0.19^{a}
Chicken Only	42.77 ± 0.61^{b}	62.42 ± 1.72^{a}	62.82 ± 1.71^{a}
Macaroni Only	56.28 ± 0.50^{b}	61.24 ± 2.18^{a}	56.55 ± 0.71^{b}
Carrot Only	49.85 ± 1.08^{a}	46.46 ± 2.35^{ab}	44.57 ± 1.18^{b}

[a-c] The means with different superscripts letter in the same row indicates significance difference ($p \leq 0.05$). The value was mean ± S

Table 4.1.1 shows the mean for the lightness (L^*) value of chicken meat mixed with macaroni that had been cooked with the different cooking method. The statistical results that indicated the colour parameter of the chicken and macaroni were affected by different cooking methods. The highest L^* value (62.82) observed for chicken meat was the one that had been cooked by air fry method while the lowest of L^* value (42.77) was chicken meat that been cooked by deep fry method.

The lightness of the chicken meat was caused by the denaturation of the muscle when it begins to break down. When the white meat undergoes further heating it causes the denatured of the protein to recombine, turning opaque and white in colour (Jared, 2011).

For macaroni, the highest L^* value (61.24) achieved by oven method whereas the lowest (56.28) was cooked by deep fry method. The L^* value of macaroni was slightly differenced among the cooking method because of the changes colour was barely seen. According to the Pietrasik (1999), highly starch contains in a food, the colour of the food after cooked do not change on a big scale. It is being proofed by the studied of Pietrasik (1999) that showed the colour of the sausages that contain high starch, the colour change is the lowest compared too other binders.

While for commercial and chicken meat with macaroni sample the highest for both of it on L^* values at air fry method which 65.12 ± 0.49^a and 66.13 ± 0.19^a respectively. Whereas for carrot the highest L^* value was at deep fry method 49.85 ± 1.08^a.

4.1.2 Redness Values of Chicken Meat Mixed with Macaroni Prepared by Different Cooking Method

Table 4.1.2 Redness (*a**) values of chicken meat mixed with macaroni prepared by the different cooking method.

Cooking Method	Deep Fry	Oven	Air Fry
	Mean ± SD	Mean ± SD	Mean ± SD
Sample			
Commercial	10.11 ± 3.54[a]	7.29 ± 0.50[b]	3.36 ± 0.12[c]
Chicken Meat and Macaroni	10.45 ± 3.23[a]	6.18 ± 0.45[b]	2.38 ± 0.10[b]
Chicken Only	4.49 ± 0.68[c]	14.36 ± 0.60[a]	5.94 ± 0.76[b]
Macaroni Only	2.00 ± 0.14[ab]	4.26 ± 1.95[a]	1.59 ± 0.24[b]
Carrot Only	26.61 ± 0.99[a]	23.91 ± 1.27[b]	25.86 ± 1.91[b]

[a-c] The means with different superscripts letter in the same row indicates significance difference ($p \leq 0.05$). The value was mean ± SD

In table 4.1.2 showed the redness (*a**) value of chicken meat and macaroni that had been cooked with the different cooking method. The table showed that the highest *a** value of 14.36 for chicken meat was cooked by oven method while the lowest value of 4.49 was by the chicken meat that cooked in deep fry method. During the cooking process of oven method, it reacts chemically with haemoglobin in the meat tissue to give it a pink tinge.

Table 4.1.2 also showed that the highest *a** value for macaroni was 4.26 when it cooked by oven method while the lowest value was 1.59 that cooked by air fry. Cooking of macaroni in water makes the density of the macaroni change and thus altering the shade of pasta and the shade does not change in a large scale when been cooked by another

method. The* value of chicken showed a significance difference ($p \leq 0.05$) with the cooking method while macaroni showed there was no significant difference ($p \geq 0.05$) with the cooking method. Also commercial, chicken meat and macaroni which highest at deep fry by 10.11 ± 3.54^{a} and 10.45 ± 3.23^{a} respectively. For carrot also deep fry was the highest value for *an** at 26.61 ± 0.99^{a}.

4.1.3 Yellowness Values of Chicken Meat Mixed with Macaroni Prepared by Different Cooking Method.

Table 4.1.3 Yellowness (*b**) values of chicken meat mixed with macaroni prepared by the different cooking method

Cooking Method	**Deep Fry**	**Oven**	**Air Fry**
	Mean ± SD	**Mean ± SD**	**Mean ± SD**
Sample			
Commercial	21.55 ± 0.71b	32.11 ± 0.60a	17.64 ± 0.50c
Chicken Meat and Macaroni	20.35 ± 0.64^{b}	35.06 ± 2.85^{a}	16.89 ± 0.16^{b}
Chicken Only	18.00 ± 0.66^{b}	18.72 ± 1.83^{a}	25.75 ± 0.77^{b}
Macaroni Only	18.70 ± 0.87^{b}	17.84 ± 1.08^{a}	28.78 ± 3.92^{b}
Carrot Only	28.13 ± 0.19^{c}	26.01 ± 0.96^{a}	43.74 ± 2.64^{b}

[a-c] The means with different superscripts letter in the same row indicates significance difference ($p \leq 0.05$). The value was mean ± SD

Yellowness (*b**) value of chicken and macaroni that cooked by different cooking method were showed in Table 4.2.3. The highest b* value had been recorded was 25.75 of chicken meat that cooked by air fry method while the lowest 18.00 by deep fry method. Macaroni showed that the air fry method recorded the highest of *b** value of 28.78 while the lowest was 17.84 recorded by the oven method.

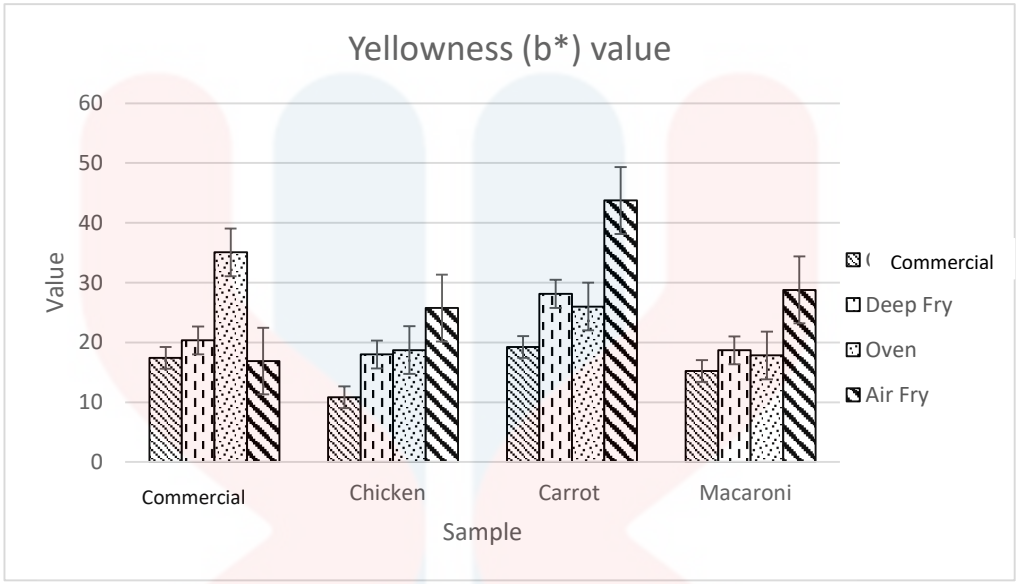

Figure 4.1.3 Yellowness (*b**) value of chicken and macaroni of different cooking method.

Air fry method affected the yellowness of the chicken meat and macaroni Based on the Figure 4.1.3 only chicken meat and macaroni that cooked by air fry method has the highest value of yellowness compared to another cooking method. For deep fry and oven, there was only a slight difference in yellowness for chicken and macaroni.

For *b** value of commercial and chicken meat and macaroni the highest was at oven method (32.11 ± 0.60^{a}, 35.06 ± 2.85^{a}). In terms of carrot, the highest value was at air fry method where the mean was 43.74 ± 2.64^{b}.

Based on the Table 4.1.1, 4.1.2, and 4.1.3, chicken and macaroni had shown that cooked by air fry has the highest value. There is not much difference between those that cooked by deep fry and oven method. The *L**, *a** and *b** value of chicken meat and macaroni showed a significance difference ($p \leq 0.05$) with the cooking method

4.2 Texture Attribute of Chicken Meat Mixed with Macaroni Prepared by Different Cooking Method

4.2.1 Hardness Values of Chicken Meat Mixed with Macaroni Prepared by Different Cooking Method

Table 4.2.1. Hardness values (g) of chicken meat mixed with macaroni prepared by the different cooking method

Cooking Method	**Deep Fry**	**Oven**	**Air Fry**
	Mean ± SD	**Mean ± SD**	**Mean ± SD**
Sample			
Commercial	3144.00 ± 59.25	3021 ± 41.25	2981.00 ± 22.19
Chicken Meat and Macaroni	3123.33 ± 31.47	3053.00 ± 37.00	3109.67 ± 53.82
Chicken Only	5074.33 ± 37.07[b]	5253.33 ± 90.67[a]	5155.00 ± 57.03[ab]
Macaroni Only	5133.00 ± 95.39	5536.00 ± 449.05	5408.33 ± 15.28
Carrot Only	5357.33 ± 87.18	5527.00 ± 300.40	5836.67 ± 222.79

[a-b] The means with different superscripts letter in the same row indicates significance difference ($p \leq 0.05$). The value was mean ± SD

Hardness is often associated with the tensile strength of the sample (Guine & Marques, 2013). From the Table 4.2.1, the deep fry method had been recorded as the lowest value for the hardness of both chicken and macaroni which 5074.33 g and 5133.00 g respectively. The highest of the hardness of both chicken and macaroni were recorded by oven method that showed 5155.00 g and 5536.00 g respectively. The hardness of value showed a significant difference ($p \leq 0.05$) while macaroni showed no significant difference ($p \geq 0.05$) with the cooking method.

The similar results were recorded by Choi *et. al* (2016) that showed the hardness of the meat in the oven was slightly high in hardness value than deep fry. Meat that undergoes oven heating were results in a higher shear force than the other cooking method (Jeon *et. al*, 2013).

For commercial the highest would be by deep fry while the lowest was air fry method at 3144.00 ± 59.25 and 2981.00 ± 22.19 respectively. The chicken and macaroni highest value for hardness was at deep fry method 3123.33 ± 31.47 while carrot at the air fry method at 5836.67 ± 222.79.

4.2.2 Springiness Values of Chicken Meat Mixed with Macaroni Prepared by Different Cooking Method

Table 4.2.2 Springiness values (mm) of chicken meat mixed with macaroni prepared by the different cooking method.

Cooking Method	**Deep Fry**	**Oven**	**Air Fry**
	Mean ± SD	**Mean ± SD**	**Mean ± SD**
Sample			
Commercial	19.52 ± 0.88^{b}	18.49 ± 0.71^{b}	20.13 ± 0.85^{a}
Chicken Meat and Macaroni	9.49 ± 0.13^{b}	7.32 ± 1.46^{b}	10.06 ± 0.28a
Chicken Only	4.57 ± 0.68^{b}	7.63 ± 0.67^{ab}	9.37 ± 0.81^{a}
Macaroni Only	5.72 ± 0.03^{a}	9.61 ± 0.75^{b}	10.38 ± 0.17^{b}
Carrot Only	28.46 ± 36.43	12.32 ± 7.42	6.97 ± 1.50

$^{a-b}$ The means with different superscripts letter in the same row indicates significance difference ($p \leq 0.05$). The value was mean ± SD

Table 4.2.2 showed the value of springiness of the chicken and macaroni with the different cooking method. The highest value of the chicken (9.37 mm) and macaroni (10.38 mm) was recorded from the same method which was air fry method. For the lowest value of springiness for both chicken and macaroni were obtained at the deep fry method which was 4.57 mm and 5.72 mm respectively. Both chicken and macaroni were significantly different ($p \leq 0.05$) with the different cooking method.

As for commercial and chicken meat and macaroni, the highest value would be at air fry method while the lowest was at oven method. in terms of carrot, the highest would be at deep fry (28.46 ± 36.43) and lowest was at air fry (6.97 ± 1.50)

4.2.3 Chewiness Values of Chicken Meat Mixed with Macaroni Prepared by Different Cooking Method.

Table 4.2.3 Chewiness value (mJ) of chicken meat mixed with macaroni prepared by the different cooking method.

Cooking Method	**Deep Fry**	**Oven**	**Air Fry**
	Mean ± SD	**Mean ± SD**	**Mean ± SD**
Sample			
Commercial	223.63 ± 100.36	181.73 ± 17.89	211.09 ± 65.62
Chicken Meat and Macaroni	233.43 ± 82.78	190.07 ± 13.84	253.43 ± 63.01
Chicken Only	197.37 ± 10.11	275.33 ± 82.73	349.33 ± 63.64
Macaroni Only	433.49 ± 1.23[a]	453.33 ± 43.05[a]	460.80 ± 58.23[a]
Carrot Only	316.78 ± 35.71[b]	174.60 ± 58.42[b]	370.73 ± 114.12[a]

[a-b] The means with different superscripts letter in the same row indicates significance difference ($p \leq 0.05$). The value was mean ± SD

Chewiness is a measure of energy that required in order to chew a solid food to the point adequate for swallowing and is the product of gumminess and springiness (More & Owen, 2017). Table 4.2.3 shows the value of chewiness of the chicken and macaroni of different cooking method. The highest chicken and macaroni value for springiness were recorded by air fry method with 349.33 mJ and 460.80 mJ respectively. For the lowest both chicken and macaroni were recorded at the deep fry method with 197.37 mJ and 433.49 mJ respectively and both of it showed that there was a significant difference ($p \leq 0.05$) with the cooking methods.

The texture of macaroni from different cooking method was slightly different with a close margin. This is because when macaroni been boiled before cooked with a different method, the starch gelatinisation and protein coagulation had caused a major structural change and hence give the firmness texture of macaroni.

During the cooking process, the protein in macaroni absorbed water and the protein fraction of pasta was hydrate before the beginning of starch gelatinisation appears to form a soft and firmness pasta texture (Sozer & Kaya, 2008).

Commercial value for chewiness at deep fry was the highest (223.63 ± 100.36) while for chicken meat and macaroni and also the highest would be at air fry method. The mean value for both of it were 253.43 ± 63.01 and 370.73 ± 114.12^{a} respectively.

4.3 Proximate Composition of Chicken Meat Mixed with Macaroni Prepared by Different Cooking Method

Table 4.3 Percentage of proximate composition of chicken meat mixed with macaroni prepared by the different cooking method.

Cooking Method		**Deep Fry**	**Oven**	**Air Fry**
Analysis	**Sample**			
Moisture Content (%)	**Commercial**	60.11 ± 2.10	58.91 ± 1.13	64.33 ± 0.21
	Chicken Meat and Macaroni	56.80 ± 1.10^{b}	56.26 ± 1.00^{b}	63.45 ± 2.16^{a}
	Chicken Only	60.33 ± 0.69^{b}	54.22 ± 0.01^{c}	72.93 ± 0.01^{a}
	Carrot Only	34.09 ± 0.02^{b}	17.39 ± 0.01^{c}	42.15 ± 0.07^{a}
	Macaroni Only	43.76 ± 0.35^{b}	43.27 ± 0.01^{b}	58.43 ± 0.06^{a}
Crude Fat (%)	**Commercial**	52.34 ± 0.21	5.70 ± 0.31	5.32 ± 0.12
	Chicken Meat and Macaroni	47.67 ± 0.41^{a}	5.20 ± 0.24^{b}	4.59 ± 0.17^{b}
	Chicken Only	46.16 ± 0.18^{a}	3.87 ± 0.05^{b}	1.97 ± 0.014^{c}
	Carrot Only	0.03 ± 0.02^{b}	0.04 ± 0.01^{a}	0.03 ± 0.01^{b}
	Macaroni Only	0.57 ± 0.01^{a}	0.16 ± 0.01^{b}	0.02 ± 0.01^{c}
Crude Protein (%)	**Commercial**	35.19 ± 0.51	40.12 ± 0.08	34.79 ± 0.12
	Chicken Meat and Macaroni	36.91 ± 0.69	38.50 ± 0.37	35.03 ± 0.24
	Chicken Only	34.51 ± 0.07^{b}	35.31 ± 0.04^{a}	35.69 ± 0.04^{a}

	Carrot Only	5.17 ± 0.04^{a}	3.94 ± 0.07^{b}	5.15 ± 0.11^{a}
	Macaroni Only	6.14 ± 0.07^{b}	6.74 ± 0.06^{b}	7.20 ± 0.04^{a}
Ash Content (%)	**Commercial**	2.30 ± 0.21	2.70 ± 0.32	2.54 ± 0.05
	Chicken Meat and Macaroni	1.28 ± 0.02^{b}	1.41 ± 0.01^{a}	1.34 ± 0.03^{b}
	Chicken Only	5.34 ± 0.06^{b}	5.50 ± 0.01^{a}	5.70 ± 0.01^{a}
	Carrot Only	0.29 ± 0.01^{a}	0.28 ± 0.02^{a}	0.04 ± 0.01^{b}
	Macaroni Only	0.34 ± 0.02^{c}	0.42 ± 0.01^{b}	0.51 ± 0.01^{a}

[a-b] The means with different superscripts letter in the same row indicates significance difference ($p \leq 0.05$). The value was mean ± SD

Table 4.3 shows the percentage of the chicken and macaroni from the different cooking method of proximate analysis. In this table the highest percentage of moisture content for chicken and macaroni when it cooked by air fry method while the lowest was cooked by cooked by oven method. The highest moisture percentage for chicken and macaroni were 63.45% and 58.43% while the lowest was 54.22% and 43.27% respectively with significance difference ($p \leq 0.05$) with cooking methods. This is due to the moisture content loss was lower than the other cooking method. According to the Dueik *et. al* (2009), food that been cooked by vacuum conditions like air frying tend to expose to the lower temperature. The micro-structural of the food will be changed or damaged are impaired at the end of the results and the sample surface faced change to prevent water from escaping during the process. A similar result also can be found by Guangku *et. al* (2014) where breaded shrimp that cooked by vacuum-fried had higher moisture than the traditional frying which was the deep fry method.

In the same Table of 4.3, the highest percentage of fat content for chicken and macaroni were in deep fry method while the lowest was in air fry method. The highest percentage of fat content for chicken and macaroni were 46.16% and 0.57% while the lowest were 1.97% and 0.02% respectively with a significance difference ($p \leq 0.05$). Deep fry method was the highest of fat content because of the oil absorption that occurs during the cooking process whereas in the air fry method there was only a little amount of oil absorption that occurs. The oil content in food is higher when the food sample been frying at the lower temperature (Aman, 2008). Oil in the cooking process is the main contributors of fat, especially to the frying food. The results had been agreed by the finding from Bauman and Escher (1995), Duran *et. al* (2007) when they compared the uptake of the oil for frying samples at different oil temperature

Various studies had shown that most of the oil from frying process does not penetrate food sample immediately during the process on the contrary during the cooling period after the product been removed from the fryer (Moreira *et al*., 1999). In air frying method that happened to have the lowest percentage of fat content because of the increasing temperature during the process occur. The similar results can be observed by Bello *et al*. (2009) where the fat content in fried fillet was the lowest when cooked with by air frying method due to the low oil-uptake when the process occurs.

For the percentage of crude protein, the highest for chicken and macaroni occurred at the air fry method for 35.69% and 7.20% respectively. The lowest for chicken and macaroni was at the deep fry method with only 34.51% and 6.14% respectively. There was significantly different ($p \leq 0.05$) in ash content of the chicken and macaroni to different cooking method. Protein goes through certain chemical changes when it is heated and cooked. When the proteins in food are heated, they coagulate, which means they become firm. When exposed to hot temperatures, the protein shrinks and loses

moisture. When meat sources of protein are cooked slowly, any connective tissues are likely to dissolve. Heat does not destroy the protein in food, though it might reduce the overall content slightly (Ipantenco, 2002)

The highest ash content for chicken and macaroni were 5.70% 0.56% respectively by air fry method. The lowest ash content recorded for chicken was at air fry method same goes with macaroni which was 5.34% and 0.34% respectively. The results indicated that among the different cooking method did not give a much different content of protein and ash in chicken and macaroni. Cooking method does not destroy or loss the minerals inside the food. It only reduced slightly among the cooking process. The mineral losses from cooking are low that they are overshadowed by background variation of other nutrient samples.

Minerals are not lost due to heat but are usually leached if cooked in boiling water, steaming is probably the best cooking method with respect to mineral loss. Otherwise, heating does not destroy minerals (Marshall, 2010)

According to the Fillion and Henry (1998), frying or baking only has a little or literally no impact on the protein or mineral content of the food.

4.4 Total Plate Count of Chicken Meat Mixed with Macaroni

Total plate count that contained nutrient agar as a medium was used to detect the viable of colonies inside the samosa throughout the period of 98 days. The number of colonies showed a significant difference between days for CFU count with $p \leq 0.05$. The mean CFU showed the highest count in Day 98 for 7.5×10^3 cfu/ml The number of

colonies started to appear on the 28th day. The number of colonies on that day was 1.8 x 10^3 cfu/ml. Throughout 98 days there were increasing in the number of the colony in the frozen samosa.

The lowest mean of CFU showed in Day 0 and 14. Both of the days showed zero colonies in the plate agar According to Guidelines for the Interpretation of Results of Microbiological Testing of Ready-to-Eat Foods Placed on the Market (Revision 2) Guidance, it stated that the number of cfu/ml must not exceed < 10^4 to obtain satisfactorily and $10^4$to 10^7 were at the borderline.

4.5 Sensory Acceptability of Chicken Meat Mixed with Macaroni Prepared Using Different Cooking Method

Table 4.5 Sensory Acceptability of Chicken Meat Mixed with Macaroni

Samples	Colour	Aroma	Crispiness	Hardness	Juiciness	Overall Acceptance
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Deep Fry	4.12 ± 0.37^{ab}	4.13 ± 0.65^{b}	3.82 ± 0.65^{b}	3.82 ± 0.72^{b}	3.95 ± 0.67^{b}	4.02 ± 0.50^{b}
Oven	4.08 ± 0.53^{a}	4.37 ± 0.69^{b}	4.12 ± 0.69^{b}	4.15 ± 0.78^{a}	4.17 ± 0.74^{b}	4.42 ± 0.67^{a}
Air Fry	4.08 ± 0.53^{b}	4.37 ± 0.69^{a}	4.15 ± 0.71^{a}	4.18 ± 0.72^{b}	4.20 ± 0.75^{a}	4.45 ± 0.67^{a}

a-b The means with different superscripts letter in the same row indicates significance difference ($p \leq 0.05$). The value was mean ± SD

Table 4.5 shows that the average colour attribute rating for three different samples from the different cooking method deep fry, oven and air fry. Colour attributes mean the appearance of chicken meat mixed with macaroni and the first impression given by panellist. For colour acceptance, chicken meat mixed with macaroni that cooked by deep fry received the highest mean score at 4.12 ± 0.37, followed by the oven and air fry that had the same mean score 4.08 ± 0.53. There is a significance difference ($p \leq 0.05$) between the sample and the colour attribute.

For aroma attribution part, panellist rated that chicken meat mixed with macaroni prepared by the oven and air fry method are the highest with the mean score 4.37 ± 0.69. The lowest score is obtained by deep fry at 4.13 ± 0.65. There was some panellist commented that sample of chicken meat mixed with macaroni that cooked by deep fry smelled oily instead of the aroma of the food than the other sample.

In terms of crispiness attribution, once again the panellist score chicken meat mixed with macaroni cooked by air fry method as the highest with 4.15 ± 0.71 and the lowest is deep fry at 3.82 ± 0.65. For the second highest is oven method at 4.12 ± 0.69 and it slightly lower than air fry. Based on the table, the crispiness between the oven method and air fry method is not big because the process of the cooking method is nearly the same.

For hardness attribution, the highest mean score is chicken meat mixed with macaroni that cooked by air fry method at 4.18 ± 0.72 while the lowest is deep fry 3.82 ± 0.72. The second highest for hardness attribution is 4.15 ± 0.78 of the oven that slightly lower than air fry method. According to panellist, they commented that sample cooked by deep fry mushier than another sample because of the absorbents of the oil

Juiciness is the condition where the food has a lot of juice and is very enjoyable to eat. For this attribution, the highest score is air fry method at 4.20 ± 0.75 and the second highest by oven method at 4.17 ± 0.74. The lowest score will be deep fry at 3.95 ± 0.67. This is because in air fry the moisture of the food is trapped in rather than evaporate during cooking process while for deep fry the moisture of the food is substitute with the oil uptake and instead of getting more moisture it full with oil.

For the last attribute to be discussed is overall acceptance which is a significant difference among the samples. The air fry method was scoring the highest for the last attribution at 4.45 ± 0.67. Whereas, deep fry is still the lowest means among the sample 4.02 ± 0.50 and for oven sample it comes behind the air fry at 4.42 ± 0.67.

From the above analysis, it indicated that chicken meat mixed with macaroni prepared using air fry method chicken meat mixed with macaroni remained as the preferred choice by panellist since it scores highest mean for five attributions out of six. On the other hand, a sample that cooked by oven showed good popularity among the panellist for each attribution although it showed slightly lower than air fry method. For the deep fry method, it received the lowest score for all the attribution.

The panellist said that chicken mixed with macaroni cooked by deep fry is oily and overall is not good to consume as to them deep fried food is not good for health. Overall, the air fry method is the method that well received by the panellist in the term for the consumer to consume fried food.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

In the present study, the colour analysis of chicken and macaroni showed cooking without oil produced lighter colour than cooking with oil. Highest lightness and yellowness and lowest redness intensity of the chicken was showed in air fry method which is 62.42 ± 1.72, 25.75 ± 0.77 and 5.94 ± 0.76 respectively. Macaroni showed that highest in lightness and redness but lowest in yellowness intensity in oven method which is 61.24 ± 2.18, 4.26 ± 1.95 and 17.84 ± 1.08. For the texture of the chicken and macaroni, the air fry method showed that the highest for springiness and chewiness while hardness showed that it not greatly affected by different cooking method. The hardness, springiness and chewiness range for chicken is 5074.33-5155 g, 4.57-9.37 mm and 197.37-349.33 mJ respectively while for macaroni 5133-5536 g, 5.72-10.38 mm and 433.49-460.80 mJ respectively. Meanwhile for nutritional composition of chicken and macaroni cooked by air fry method showed the highest value in terms of moisture (72.93 ± 0.01) and (58.43 ± 0.06), protein (35.69 ± 0.04) and (7.20 ± 0.04), ash (5.70 ± 0.01) and (0.51 ± 0.01) and lowest

value for fat (1.97 ± 0.014) and (0.02 ± 0.01). In terms of sensory panellist did give the highest score to air method for five out of six attributions It can be concluded that chicken and macaroni cooked by air fry method showed good results compared to another cooking method. Last but not least, the total plate count of chicken meat mixed with macaroni showed that the highest value cfu/ml was at day 98 It indicates that the frozen storage can last long more than two weeks. Overall the air fry method proved to be the best cooking method among deep fry and oven method.

5.2 Recommendation

In a future study or research can work on the nutritional composition that can be offered by air fry method. Besides, there is also a great potential in air fry method in developing a good substitute for fried food in terms of health-promoting than a traditional deep fry. Not only that, researchers can research in the future about how or initiatives to reduce the use of oil-based frying methods. This is to reduce the obesity or heart disease method which is a major factor in taking excessive oily foods regularly. With such research, residents can enjoy healthy fried foods. In the future, researchers will also be able to find solutions to extend the life of frozen foods that contain raw materials to last longer

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APPENDICES

APPENDIX A

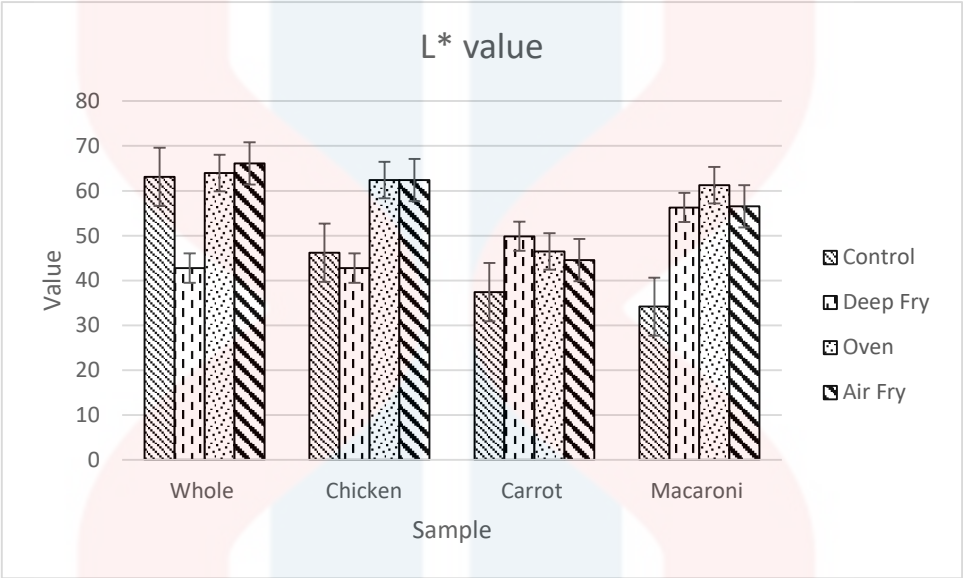

Figure 4.1.1 Lightness (L*) value of chicken and macaroni of different cooking method.

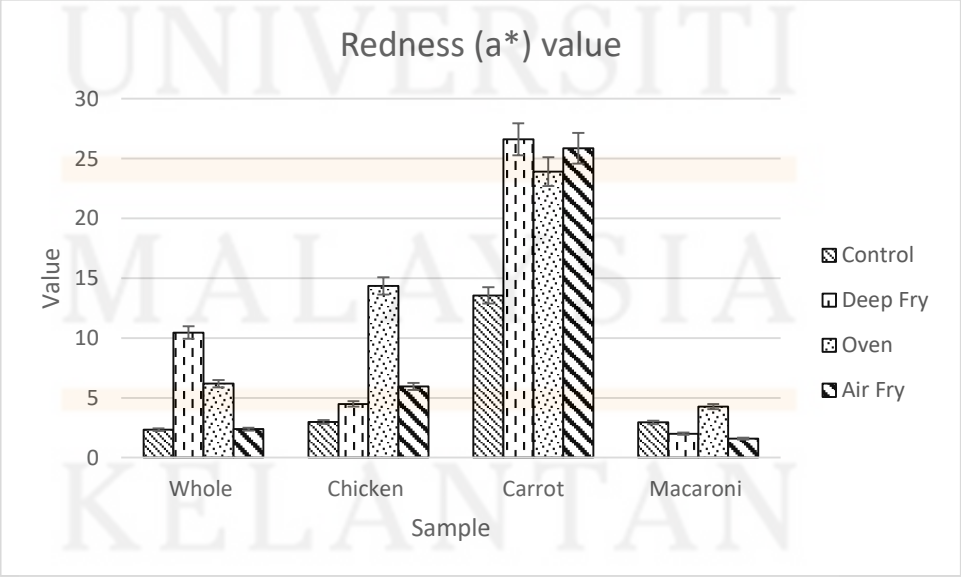

Figure 4.1.2 Redness (a*) value of chicken and macaroni of different cooking method.

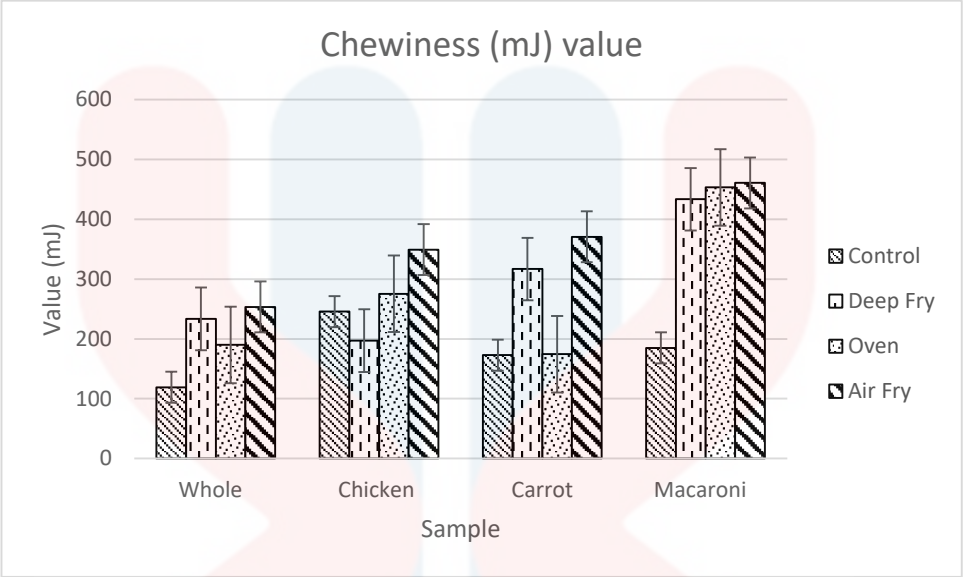

Figure 4.2.3 Chewiness (mJ) value of chicken and macaroni of different cooking method.

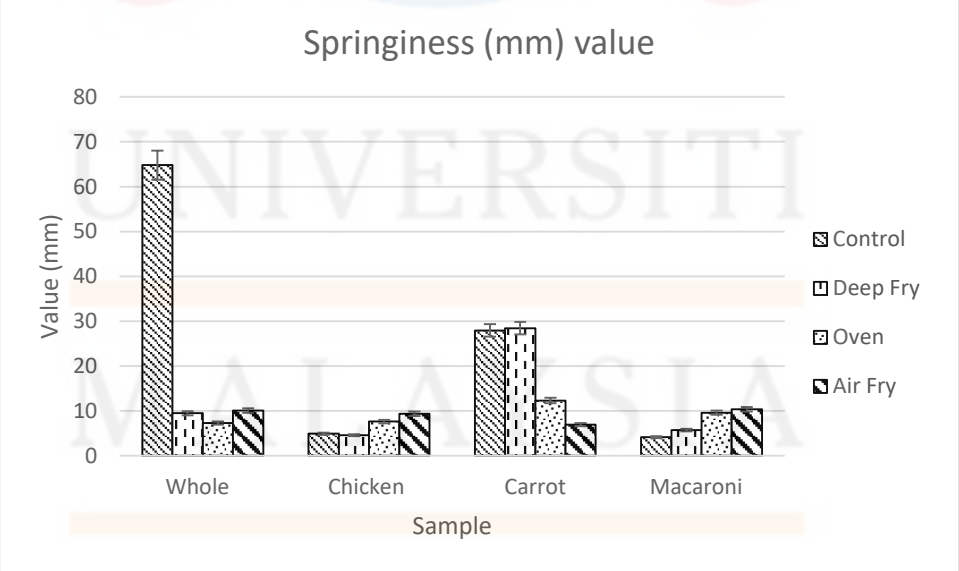

Figure 4.2.2 Springiness value (mm) of chicken meat mixed with macaroni prepared by using the different cooking method

APPENDIX B

Table 4.1.2 ANOVA table of *a** value for chicken meat mixed with macaroni prepared by using the different cooking method

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
a* value	Between Groups	233.478	3	77.826	192.623	.000
	Within Groups	3.232	8	.404		
	Total	236.710	11			
Ingredients	Between Groups	.000	3	.000	.	.
	Within Groups	.000	8	.000		
	Total	.000	11			

Table 4.1.3 ANOVA table for yellowness of chicken meat mixed with macaroni prepared by using the different cooking method.

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
b* value	Between Groups	333.960	3	111.320	80.454	.000
	Within Groups	11.069	8	1.384		
	Total	345.029	11			
Ingredients	Between Groups	.000	3	.000	.	.
	Within Groups	.000	8	.000		
	Total	.000	11			

Table 4.1.1 ANOVA table for the lightness of chicken meat mixed with macaroni prepared by using the different cooking method

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
L* value	Between Groups	1163.130	3	387.710	37.559	.000
	Within Groups	82.581	8	10.323		
	Total	1245.711	11			
Ingredients	Between Groups	.000	3	.000	.	.
	Within Groups	.000	8	.000		
	Total	.000	11			

Table 4.5 ANOVA table for overall acceptance of chicken meat mixed with macaroni prepared by using the different cooking method

ANOVA

Overall Acceptance Value

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	35.700	3	11.900	24.414	.000
Within Groups	115.033	236	.487		
Total	150.733	239			

Table 4.5 Duncan table for overall acceptance of chicken meat mixed with macaroni prepared by using the different cooking method.

Overall Acceptance Value

Duncan

A,B,C,D	N	Subset for alpha = 0.05		
		1	2	3
D	60	3.7000		
B	60		4.0167	
C	60			4.4500
A	60			4.7000
Sig.		1.000	1.000	.051

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 60.000.

Table 4.3 ANOVA table for the fat content of chicken meat mixed with macaroni prepared by using the different cooking method.

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
percentage value	Between Groups	3725.005	2	1862.503	36056.190	.000
	Within Groups	.310	6	.052		
	Total	3725.315	8			
Ingredients	Between Groups	.000	2	.000	.	.
	Within Groups	.000	6	.000		
	Total	.000	8			

Table 4.3 Tuckey table of the fat content of chicken meat mixed with macaroni prepared by using the different cooking method.

percentage value

Tukey HSD[a]

Cooking Method	N	Subset for alpha = 0.05		
		1	2	3
Air Fry	3	2.1567		
Oven	3		3.9100	
Deep Fry	3			46.1633
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Table 4.3 Tuckey table of the moisture content of chicken meat mixed with macaroni prepared by using the different cooking method.

percentage value

Tukey HSD[a]

Cooking Method	N	Subset for alpha = 0.05		
		1	2	3
Oven	3	54.2233		
Deep Fry	3		60.3333	
Air Fry	3			72.9267
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Table 4.3 Tuckey table of the ash content of chicken meat mixed with macaroni prepared by using the different cooking method

percentage value

Tukey HSD[a]

Cooking Method	N	Subset for alpha = 0.05	
		1	2
Air Fry	3	.1467	
Deep Fry	3		5.6467
Oven	3		5.8100
Sig.		1.000	.061

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Table 4.3 ANOVA table of the moisture content of chicken meat mixed with macaroni prepared by using the different cooking method.

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
percentage value	Between Groups	545.739	2	272.869	1717.240	.000
	Within Groups	.953	6	.159		
	Total	546.692	8			
Ingredients	Between Groups	.000	2	.000	.	.
	Within Groups	.000	6	.000		
	Total	.000	8			

Table 4.3. Tuckey table of chicken meat mixed with macaroni prepared by using the different cooking method

percentage value

Tukey HSD[a]

Cooking Method	N	Subset for alpha = 0.05		
		1	2	3
Oven	3	54.2233		

Deep Fry	3		60.3333	
Air Fry	3			72.9267
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Table 4.3 ANOVA table of the protein content of chicken meat mixed with macaroni prepared by using the different cooking method

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
percentage value	Between Groups	2.418	2	1.209	284.149	.000
	Within Groups	.026	6	.004		
	Total	2.444	8			
Ingredients	Between Groups	.000	2	.000	.	.
	Within Groups	.000	6	.000		
	Total	.000	8			

Table 4.3 ANOVA table of the ash content of chicken meat mixed with macaroni prepared by using the different cooking method

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
percentage value	Between Groups	62.350	2	31.175	6601.767	.000
	Within Groups	.028	6	.005		
	Total	62.378	8			
Ingredients	Between Groups	.000	2	.000	.	.
	Within Groups	.000	6	.000		
	Total	.000	8			

Table 4.3 ANOVA table of the fat content of chicken meat mixed with macaroni prepared by using the different cooking method

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
percentage value	Between Groups	3725.005	2	1862.503	36056.190	.000

	Within Groups	.310	6	.052		
	Total	3725.315	8			
	Between Groups	.000	2	.000	.	.
Ingredients	Within Groups	.000	6	.000		
	Total	.000	8			

APPENDIX C

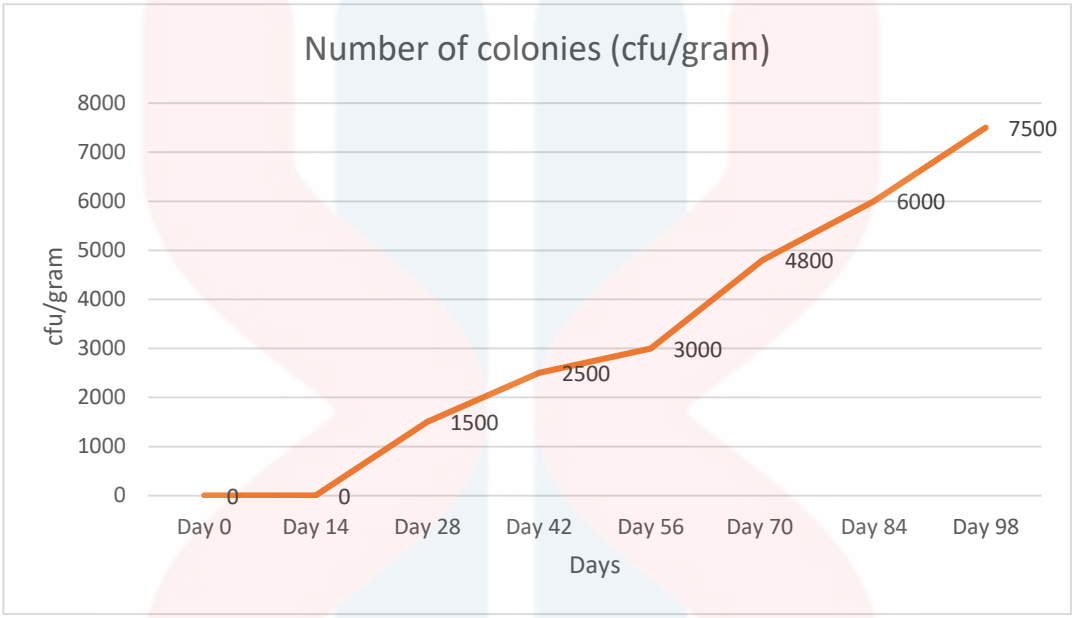

Figure 4.4 Graph of colonies for frozen storage of chicken meat mixed with macaroni