UNIVERSITI MALAYSIA KELANTAN

Effect of Paste Additive on The Physical Properties of Tilapia Fillet

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A proposal submitted in fulfilment of the requirements for the degree of Bachelor of Applied Science (Animal Husbandry Science) with Honours

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Universiti Malaysia Kelantan

2021

DECLARATION

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

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ACKNOWLEDGEMENT

First and foremost, praises and thanks to the God, the Almighty, for His showers of blessings throughout my research work to complete the research successfully.

I would like to express my deep and sincere gratitude to my research supervisor, Prof. Madya Dr. Lukman B Ismail and Ts Dr. Hasnita Binti Che Harun for giving me the opportunity to do research and providing invaluable guidance throughout this research. Their dynamism, vision, sincerity and motivation have deeply inspired me. It was a great privilege and honor to work and study under their guidance. I also greatly thanks to Encik Suhaimi B Omar, Encik Abdul Khaliq bin Zakaria and Puan Nur Aiashah Binti Ibrahim for their help in assisting me in lab who has helped me with the setup for the project and gave practical insight.

I am extremely grateful to my parents for their love, prayers, caring and sacrifices for educating and preparing me for my future. Also I express my thanks to my sister, brothers, sister in for their support and valuable prayers. My Special thanks goes to my friends for the keen interest shown to complete this thesis successfully. This project would not have come so far without support from the people I mentioned before. I'm indebted to you all. I believe that this small project will make a significant impact by inspiring someone else to continue my research. Thank you.

Effect of Paste Additive on The Physical Properties of Tilapia Fillet

ABSTRACT

The demand to eat ready to cook food are increasing because of the employment are increasing but the conventional packaging would alter the texture and freshness of the product. Therefore, tilapia as the second place after carps as a farm food fish are chosen to determine the acceptance of people towards different ratio of paste and fish using sensory evaluation test then to determine the effect of retort process on physio-chemical properties of tilapia fillet with paste and third is to investigate the ability of retort processing in eliminating microbes in tilapia fillet with paste. The parameter used were sensory evaluation, sterility test, and physio chemical test including proximate analysis, textural analysis, pH test and colorimeter test. After the sample preparation, the sensory evaluation was tested and treatment 2 was the most chosen by all the 50 panellist. There were no significant variations in the fish fillet products in terms of colour, flavour, chewiness, succulence, toughness, fibrosity, and overall acceptability. Next is sterility test, throughout the storage time, the chosen samples were examined for total plate count after 24hrs, but no microbial growth was discovered in any of them. It means that the microbes were completely eliminated by the heat procedure used to prepare in retort pouches. In the proximate analysis, Thermal heat frying was shown to have a significant effect on the proximate components of tilapia fish fillets ($P < 0.05$). After retort processing, the sample's protein, fibre, fat, ash, and moisture content rose. The textural profile analysis in comparison to before the retort process, the textural qualities of retort fillet with paste (R-FFP) comprising 50% paste acquire hardness, cohesiveness, springiness, and chewiness. In pH, the treatments had a substantial ($p<0.05$) impact on the pH readings, using Chroma meter, Colour data from the initial sample before and after processing was analysed, including L* (darkness to lightness), a* (redness to greenness), and b* (blue to yellowness). A small increase in yellowness (b*) was noticed in raw fish mixed with paste when the amount of paste was increased. The acceptance of people towards different ratio of paste and fish are by 50:50 ration. The effect of retort process on physio-chemical properties of tilapia fillet with paste show that the increasing trend in proximate analysis, the colour test, pH. and the texture and lastly, the ability of retort processing in eliminating microbes in tilapia fillet with paste are efficient as it helps to provide longer shelf life to the product.

Keywords
Tilapia fillet, retort packaging, optimum portion, sterilization, quality

Kesan Pes Terhadap Sifat Fizikal Isi Tilapia

ABSTRAK

Permintaan untuk makan makanan sedia untuk dimasak semakin meningkat kerana pekerjaan semakin meningkat tetapi pembungkusan konvensional akan mengubah tekstur dan kesegaran produk. Oleh itu, tilapia sebagai tempat kedua selepas ikan kap sebagai makanan ternakan ikan dipilih untuk menentukan penerimaan manusia terhadap nisbah pes dan ikan yang berbeza menggunakan ujian penilaian deria. Dan seterusnya untuk menentukan kesan proses retort terhadap sifat fiziko-kimia isi ikan tilapia dengan pes dan ketiga ialah menyiasat keupayaan pemprosesan retort dalam menghapuskan kuman dalam isi ikan tilapia dengan pes. Parameter yang digunakan ialah penilaian deria, ujian kemandulan, dan ujian fiziko kimia termasuk analisis proksimat, analisis tekstur, ujian pH dan ujian colourimeter. Selepas penyediaan sampel, penilaian deria telah diuji dan rawatan 2 adalah yang paling banyak dipilih oleh kesemua 50 ahli panel. Tiada variasi ketara dalam produk isi ikan dari segi warna, rasa, kenyal, kelembutan, keliatan, keterserabutan dan penerimaan keseluruhan. Seterusnya ialah ujian kemandulan, sepanjang masa penyimpanan, sampel yang dipilih telah diperiksa untuk jumlah kiraan plat selepas 24 jam, tetapi tiada pertumbuhan mikrob ditemui dalam mana-mana daripada mereka. Ini bermakna bahawa bakteria telah dihapuskan sepenuhnya oleh prosedur haba yang digunakan untuk menyediakan dalam kantung retort. Dalam analisis proksimat, penggorengan haba terma telah menunjukkan kesan yang signifikan terhadap komponen proksimat isi ikan tilapia (P <0.05). Selepas pemprosesan retort, protein, serat, lemak, abu dan kandungan lembapan sampel meningkat. Analisis profil tekstur berbanding sebelum proses retort, kualiti tekstur fillet retort dengan pes (R-FFP) yang terdiri daripada pes 50% memperoleh kekerasan, kepaduan, kelembutan dan kenyal. Dalam Ph, rawatan mempunyai kesan yang besar (p<0.05) pada bacaan pH, menggunakan meter kroma, Data warna daripada sampel awal sebelum dan selepas pemprosesan dianalisis, termasuk L* (kegelapan kepada cahaya), a* (kemerahan kepada kehijauan), dan b* (biru kepada kekuningan). Peningkatan kecil dalam kekuningan (b*) dapat dilihat pada ikan mentah yang dicampur dengan pes apabila jumlah pes ditambah. Penerimaan orang terhadap nisbah pes dan ikan yang berbeza adalah dengan catuan 50:50. Kesan proses retort terhadap sifat fiziko-kimia isi ikan tilapia dengan pes menunjukkan trend yang semakin meningkat dalam analisis proksimat, ujian warna, ph dan tekstur dan terakhir, keupayaan pemprosesan retort dalam menghapuskan kuman dalam fillet tilapia dengan pes adalah cekap kerana ia membantu memberikan jangka hayat yang lebih lama kepada produk.

Kata kunci

Isi tilapia, pembungkusan retort, bahagian optimum, pensterilan, kualiti

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CHAPTER 1

INTRODUCTION

1.1 Research Background

Tilapia is the essential aquaculture fish of the 21st century; it is in second place after carps as a farm food fish. Despite the massive effects of pandemic Covid-19, global tilapia production increased by 3.3 per cent in 2020, surpassing 6 million tons for the first time (Fletcher & Fletcher, 2021).

The preparation of the fillet also has to include a better way of packaging as it might affect the quality of the paste and the tilapia fillet itself. In the packaging process, it is crucial to keep the surface seasoning paste in a stable condition. Different packaging options are available. E.g. vacuum packaging, blister packaging, gas packaging, deep-drawing packaging, pillow packaging, and skin packaging, but the newest packaging option uses retort packaging. The materials used in packaging are also important, such as cellophane laminate films, polyester, nylon plastic films, vinylidene chloride plastic films, multilayer films of various plastic films in combination, and aluminium foil, among others.

Researchers have advocated a variety of paste on the tilapia fillet for generating a better quality product, but there has been less research on the quantity recommended. As a consequence, the effect of adding paste to Tilapia fillet preparation on their physical qualities, as well as the usage of the retort packaging technique, will be investigated in this study. Because of their delicacy, traditional or ethnic cuisines are essential. These items have a distinct authenticity that is only found in the place where they were produced. These items have been passed down through generations and are exclusively known by people from that specific areas. The recipes are carefully guarded and frequently passed down through the generations through word of mouth. These items are in high demand, but due to their limited shelf life, they are rarely commercialised. These goods can be frozen or prepared ready to consume. Frozen curry, despite its excellent organoleptic qualities, necessitates the use of a cold chain after preparation, as well as throughout transportation and retailing. As a result, it requires a lot of money. As a result, another option is to preserve such items in ready-to-eat condition so that they may be kept and marketed for extended periods of time. Standardization of several sorts of ready-to-eat fish items in locally manufactured retortable pouches has already been reported. Mackerel curry (Gopal *et al*., 2001), seer fish curry (Ravishankar *et al.* 2002), seerfish moli (Manju *et al.* 2004), fried mussel (Bindu *et al.* 2004), and others are among the items. In Malaysia, tilapia fish with herbs paste is a popular dish. The majority of them are sold in lunch establishments. There are also some spices and seasonings added. These items are prepared and consumed on the same day, and they have a short shelf life because to the moisture, which causes the food to get rancid. Because this product is in high demand both domestically and internationally, the present study was undertaken to standardize a long shelf stable ready-to-eat traditional product from tilapia fishes in indigenous retort pouches.

1.2 Problem Statement

In November 2021, the number of employed people increased for the fourth month in a row, with a rise of 55.7 thousand people (0.4 percent) month on month, totaling 15.61 million people (October 2021: 15.55 million persons). The employment-to-population ratio, which measures an economy's potential to produce jobs, increased by 0.2 percentage points in November 2021 to 66.0 percent (October 2021: 65.8 percent). (Department of Statistics Malaysia Official Portal, 2022). This resulting of demand in ready to eat food and parallel with the healthy and favourable food.

Malaysia is one of the countries that consumes a lot of tilapia fishes. Many buyers prefer fresh tilapia to cook but cooking also time consuming. To add on, fresh tilapia fish also have fishy smells even it is cleaned well. While Malaysians are considered to have no issues with taste and Malaysia is one of the places in the world where that has diverse variety of flavours and heritage foods, living proof of the iconic slogan "Malaysia, Truly Asia"(Nazri *et al.*, 2017). Additional preservatives to alter the taste of the fillet may affect our body system. Such as it may induce headache, high blood pressure, kidney failure, etc. Another problem is that many tilapia fillets were packed with conventional packaging that would alter the texture and freshness of the fillet. Therefore, the effect of additional paste on the preparation of tilapia properties fillet on its physical and the effect of retort packaging on tilapia fillet was studied.

1.3 Objectives

The present study aims to:

1.3.1 To determine the acceptance of people towards different ratio of paste and fish using sensory evaluation test.

1.3.2 To determine the effect of retort process on physico-chemical properties of tilapia fillet with paste.

1.3.3 To investigate the ability of retort processing in eliminating microbes in tilapia fillet with paste.

1.4 Hypothesis

H_o: The portion of paste and retort processing will not significantly affect the physico-chemical and shelf life of tilapia fillet in paste.

H_A: The portion of paste and retort processing will significantly affect the physico-chemical and shelf life of tilapia fillet in paste.

1.5 Scope of The Study

This study covers the customers' acceptance on the different ratio of paste and fish fillet. The most acceptable ration was then subjected for stability test carried out using proximate analysis and microbes count. In addition, the physical properties also carried out to determine the quality of the selected ratio paste and fish fillet.

1.6 Significance of The Study

This study provides information on the best portion of paste on tilapia fillet that is preferable by customers. The present study also contributes to the establishment of method through retort processing to produce a product that is tasty, fresh and healthy.

CHAPTER 2

LITERATURE REVIEW

2.1 *Nile* Tilapia (*Oreochromis niloticus)*

Nile Tilapia is one of the economic types of fish to consume with its soft textural mild- flavoured. Tilapia are shaped like sunfish or crappie but can be distinguished by an interrupted lateral line distinctive of the Cichlid family of fishes. They are laterally flattened and deep-bodied, with long dorsal fins (*tilapia characteristics*, 2017). The dorsal fins anterior section is deeply spine. Spines can also be located in the pelvis and anal fins. Broad vertical bars run down the sides of fry, fingerlings, and even adults. The product from tilapia has a lovely colour, white or slightly pink, and the taste is not so fishy. In the preparing and frying, the flesh is solid and says unchangeable. The meat is medium in fat but very rich in protein. Because of these advantages, tilapia fillets are often compared to other species.

2.2 Current trend of Tilapia Consumption

Malaysian Fisheries Sector, which includes aquaculture, capture fisheries and inland fisheries, have produced 1.85 MT productions with the value estimated at USD 3.3 billion (RM 14.5 billion; Department of Fisheries, Malaysia (DOF), 2020). A recent analysis provided by the Department of Fisheries Malaysia (DOF, Malaysia) showed that the Malaysian Gross Domestic Product (GDP) for Agriculture is currently around 12.5 %, with the trade value estimated at USD 1.75 billion (RM 7.5 billion; Department of Fisheries, Malaysia (DOF), 2020).

In addition, according to the Freshwater Aquaculture Production by System and Species (Department of Fisheries, Malaysia (DOF), 2020), red tilapia had the highest production value, with 31,884.53 tonnes, compared to black tilapia (3714.59 tonnes) and tilapia gift (tilapia gift) (1619.46 tans). As people become wealthier and more aware of the health advantages of eating, demand for fish is increasing. Fish consumption per capita is quite high, at over 59 kg in 2016, making it one of the world's highest.

2.3 Paste Availability

Malaysia is growing more and more fast-paced. As a result, most Malaysians do not have much time to prepare meals from scratch. It might be daunting and time-consuming to think about what to make, then go out and get the goods, prep the items, and follow a complicated recipe. As a result, rapid cooking pastes are the best option for meals that taste just as wonderful. In Malaysia, there are many different types of ready-to-eat pastes, such as Nyonya Curry, Assam Fish, Rendang, Penang Assam Laksa, and so on. With our concentration cooking paste range, this paste availability plainly helps to decrease labour hard meal preparation and deliver authenticity with quickness without losing flavour. We are enthusiastic about the ingredients we use in our sauces, ensuring that the food we serve has the distinct flavour that distinguishes Malaysian cuisine.

Malaysian cuisine blends a wide variety of herbs and spices to create a really distinctive Asian flavour. Making a genuine Malaysian sauce might be intimidating for many inexperienced cooks.

2.4 Retort Packaging

A retort is a device used in chemical laboratories for distillation or dry distillation of substances. A spherical vessel with a long downward-pointing neck makes up the structure. The distilled liquid is poured into the vessel and heated. The neck serves as a condenser, enabling vapours to condense and flow down the neck to a collection jar. As a result, the retort method is employed in the industry to sterilise the product and eliminate microbes to increase the shelf life. In the food business, pressure cookers are known as retorts, which means “canning retorts,” and are used to sterilise food at high temperatures (116–130 °C). Apart from can, there are a lot of possibilities for response nowadays. There are also pouches that stand up or lie flat.

2.5 Advantages of Retort Packaging

The rotating of packaging may be visible in the market for a limited period of time as the company seeks to make their product more appealing to customers. As a result, retort packaging is the greatest option for packaging food goods since it offers more benefits than can packaging.

The retort bag uses cutting-edge technology and materials to allow food to be prepared ahead of time. They cook the meal in these pouches with superheated water or steam. Pre-cooking the pouches makes them more enticing to customers since they require practically no preparation before use. Customers would like them if they required less cooking. Customers won't have to worry about where they'll keep their leftover food because the resealable retort packaging stand-up pouches are resealable. These pouches include a handy zip-lock closure, so you won't have to buy any other storage containers. Retort pouches allow food to cook more evenly. In retort packing, the food is evenly distributed across a vast surface area. Cooking time is decreased as a result, and cooking results are improved.

These pouches have a wide surface area on the front and rear. Manufacturers may utilise this area to build visual designs that will catch the attention of their customers. Additionally, because these pouches are manufactured using cutting-edge technology, they are better suited to contemporary printing techniques than traditional packaging media. Packaging for retorts can be hung in a peg case or displayed on store shelves. Manufacturers benefit from more exposure as a result of their flexibility. It's easier and more compact to stock retortable pouches before filling them. These packages are easier to transport and store than traditional packing since they pack flat. Several high-quality layers go into making retortable pouches. The package is more durable because of these layers. This is equivalent to the durability of tin cans.

2.6 Retort Pouch packaging

The Retort Pouch is a semi-rigid, leak-proof packaging solution constructed of heat-resistant laminated plastic that can withstand temperatures of up to 250 degrees. The pouch's heat-resistant qualities enable for the sterile packaging of a wide range of food items, making it the ideal solution for secure, frozen, and pre-packaged food.

A standard Retort Pouch comprises four layers, is FDA-approved, and has been sterilised to extend the shelf life of the package. Propylene is the first layer. It provides strength and flexibility while acting as a heat seal surface. Nylon is the second layer. This layer is responsible for the pouch's abrasion resistance. Aluminium Foil is the third layer. By serving as a screen against light, fumes, microbes, and smells, aluminium foil can assist to extend the shelf life of a product. Because of the toughness of the aluminium metal foil, the tear notch feature may be incorporated into the bag, and the last layer is polyester (Bindu *et al.,* 2012). It has a high temperature resistance, is strong, and can print graphics. The pouch with many layers reduces heat exposure, keeping and increasing the colour, scent, taste, and form of the food product, as well as limiting nutritional loss. Microwavable pouches, four-side seal pouches, zip bags, and centre seal pouches are the four most popular varieties of retort pouches.

Standing upright and being flexible not only contributes in the preservation of the fine's composition, but it also takes up no shelf space. This streamlines logistics in general by allowing more things to be delivered at the same time, saving money on freight expenses. The “tear notch” device may be fitted into the Retort Pouch to allow for faster package opening.

2.7 Retort Machine

Typically, these are vertical autoclaves with a cover on top. The objects to be sterilised are placed into the autoclave through the opening lid. Normally, the aluminium bag is arranged in metal baskets. The baskets are stapled on top of one other or placed individually in the autoclave. Before commencing the sterilisation, make sure the cover is securely fastened to the autoclave body. The autoclave and cover are rated for pressures of up to 5.0 bar. These autoclaves are best suited for modest operations because they do not require sophisticated supply lines and should be inexpensive.

2.8 Sterilization Process

Sterilization is any process that removes, kills, or deactivates all forms of life (including microorganisms, bacteria, spores, unicellular eukaryotic organisms like Plasmodium, and other biological agents like prions) from a specific surface, object, or fluid, such as food or biological culture media. Various methods of sterilisation exist, including heat, chemicals, irradiation, high pressure, and filtration. Disinfection, sanitization, and pasteurisation are different from sterilisation in that they diminish rather than remove all forms of life and biological agents. An object is referred to as sterile or aseptic once it has been sterilised. Nicolas Appert took one of the first steps toward contemporary sterilisation when he discovered that applying heat for a lengthy amount of time reduced the decomposition of foods and liquids, allowing them to be safely consumed for longer periods of time than was previously possible. Food canning is an extension of the same idea that has aided in the reduction of foodborne disease ("food poisoning"). Heat treatment is one method for sterilising food. Heat treatment stops bacterial and enzyme activity, reducing the likelihood of low-quality foods while extending the shelf life of non-perishable goods. UHT (Ultra-High Temperature) sterilisation is one sort of heat treatment that is employed. Moisture and dry heat sterilisation are the two forms of UHT sterilisation. The temperatures utilised for wet heat sterilisation range from 110 to 130 degrees Celsius. Moist heat sterilisation takes 20 to 40 minutes, with the time decreasing as the temperature rises. When opposed to wet heat sterilisation, dry heat sterilisation employs longer susceptibility durations of up to 2 hours and uses substantially higher temperatures. Temperatures might be anywhere between 160 and 180 degrees Celsius.

2.9 Death Rate Curve (D Value)

The goal of sterilisation is to reduce the number of microbes or other possible pathogens that were previously present. Multiples of the decimal reduction time, or D-value, which denotes the time required to decrease the starting number N0 to one tenth (10-1) of its original value, are widely used to represent the degree of sterilisation.

$$\frac{N}{N_0} = 10(-\frac{t}{D})$$

The D-value is determined by sterilising settings and varies depending on the microorganism, temperature, water activity, pH, and other factors. The temperature, in degrees Celsius, is usually used for steam sterilisation.

In principle, the chances of a single microorganism surviving are never zero. To compensate for this, overkill is commonly used. The overkill method to sterilisation is achieved by sterilising for longer than is required to destroy the bioburden present on or in the object being sterilised. As a result, the sterility assurance level (SAL) is the same as the probability of a non-sterile unit.

For high-risk applications such as medical devices and injections, the US Food and Drug Administration mandates a sterility assurance level of at least 106. (FDA).

2.10 Heat Steam

The autoclave, also known as a converter or steam steriliser, is a common technique for heat sterilisation. Steam is heated to 121–134 °C (250–273 °F) under pressure in autoclaves. To establish sterility, the product is put in a chamber and heated with injected steam until the temperature and time setpoints are reached. Because air is undesirable in the moist heat sterilisation process, almost all of the air is removed from the chamber (this is one trait that differs from a typical pressure cooker used for food cooking). The product is maintained at the temperature setpoint for a specific amount of time, which varies based on the amount of bioburden on the object to be sterilised and its resistance to steam sterilisation (D-value). A general cycle would be anywhere between 3 and 15 minutes at 121 °C (250 °F) at 100 kPa (15 psi) for a product with a bioburden of 106 and a D-value of 2.0 minutes (depending on the generated heat), which is sufficient to provide a sterility assurance level of 104 for a product with a bioburden of 106 and a D-value of 2.0 minutes. Liquids in a pressured autoclave must be cooled gently after sterilisation to avoid boiling over when the pressure is removed. This may be accomplished by progressively depressurizing the sterilising chamber and allowing liquids to evaporate while cooling at a negative pressure.

In addition to fungus, bacteria, and viruses, proper autoclave treatment will inactivate all resistant bacterial spores, but it is unlikely to eradicate all prions, which vary in their resistance. 121–132 °C (250–270 °F) for 60 minutes or 134 °C (273 °F) for at least 18 minutes are recommended for prion eradication.

Most autoclaves contain metres and charts that record or show data, especially temperature and pressure over time. The information is double-checked to confirm that the sterilising criteria have been satisfied. Prior to autoclaving, indicator tape is frequently applied to product containers, and some packaging includes indications. When exposed to steam, the indicator changes colour, providing visual proof.

Bioindicators can also be utilised to confirm autoclave performance independently. Simple bioindicator sensors based on microbial spores are commercially available. Most include spores of Geobacillus stearothermophilus (previously Bacillus stearothermophilus), a heat-resistant bacterium that is very resistant to steam sterilisation. Biological indicators can be in the form of spores in glass vials with liquid medium, or spores on paper strips within glassine envelopes. These indicators are used to check that steam is accessing areas where it is difficult for steam to reach.

Cleaning is essential for autoclaving. Organisms may be protected against steam penetration by extraneous organic materials or dirt. Physical scrubbing, sonication, ultrasound, or pulsed air can all be used to clean properly. Pressure cooking and canning are similar to autoclaving in that they render food sterile when done correctly. Microorganisms are destroyed by moist heat due to denaturation of macromolecules, particularly proteins. Dry heat sterilisation takes longer than this approach.

A purpose-built effluent decontamination system can be used to sterilise waste materials that are mostly liquid. These devices may be sterilised with a variety of methods, the most common of which being steam.

The optimum F0 value for fish products is between 5 and 20. An F0 score of 8.43 was reported as satisfactory for fish curry items. A F0 score of 8.79, according to Mallick *et al.*, is adequate to obtain a commercially sterile product. For Tilapia fish curry, an F0 value of 6.94 was determined to be adequate, with a CV of 107.24 min and a process time of 50.24 at 116°C. As a result, in this investigation, the same value will be utilised.

CHAPTER 3

METHODOLOGY

3.1 Experimental design

Small-sized fresh tilapia size about 6-8 inch (about 450g) were supplied by Aqua Blue Scampi Enterprise and transported on ice to the Animal Laboratory at Universiti Malaysia Kelantan (UMK), Jeli Campus. A process of proper defrosting frozen product was followed. Semi-quick defrost (place fillet into a bowl of cold water for it to get less cold) was carried out to minimise the effect on flesh quality of tilapia fillet. After 30 min, ~~put~~ the tilapia was put under running tap water for about 15 min. All fishes were cleaned by removing the head and gut using diagonal cut and the skin was pulled to get pure tilapia fillet. Lastly, the fillets were cut into small pieces with (1x1cm) and 2cm thickness. About 50± gram leaned tilapia fillet was mix with different ratio of paste. About 2000 g paste was purchased from Aqua Blue Scampi Enterprise. The percentage of paste and Tilapia fillet were based on the following ratio paste: 25%, 50%, 100% and 50g fish fillet. Thus, the samples that were analysed were raw fillet, the paste, the mixture between the raw fillet and paste, and the mixture between the retort fillet and paste as in Table 1.

Table 1: Different level of paste on fish fillet and stated as T1, T2, and T3.

Name of treatment	Raw Fillet (g)	The Paste (g)	Non Retort Fish Fillet Paste (NR-FFP)		Retort Fish Fillet Paste (R-FFP)	
			fish	paste	fish	paste
T1(a)	50	25	50	25	50	25
T1(b)	50	25	50	25	50	25
T1(c)	50	25	50	25	50	25
T2(a)	50	50	50	50	50	50
T2(b)	50	50	50	50	50	50
T2 (c)	50	50	50	50	50	50
T3(a)	50	100	50	100	50	100
T3(b)	50	100	50	100	50	100
T3(c)	50	100	50	100	50	100

The treatment data are duplicate of three.

3.2 Sensory evaluation

The panellist was given pouches of thermally treated tilapia fish fillets. Students and faculty from Universiti Malaysia Kelantan served on the panel. 50 untrained pannelist assessed the changes in sensory attributes of tilapia fish fillet samples as in figure 3.2. The three core sensory procedures are discriminative sensory assessment, informative sensory evaluation, and user sensory evaluation (Miller, 2017). As a result, a sensory score of 6 was chosen as the acceptable limit. Colour, flavour, chewiness, succulence, toughness, fibrosity, and overall acceptability were given a score of 1–10 (1 = dislike extremely; 2 = dislike very much; 3 = dislike moderately; 4 = dislike slightly; 5 = neither like nor dislike; 6 = light slightly; 7 = like moderately; 8 = like very much; 9 = like extremely; 10 = excellent). The data was presented as a mean standard error measurement.

Figure 1: sensory evaluation form for panellist.

SENSORY EVALUATION OF TILAPIA FILLET

Female/Male: Age:

Staff/ Student: Course/ Department:

Please tick (/) for your preference.

SCORE	1	2	3	4	5	6	7	8	9	10
COLOUR										
FLAVOUR										
CHEWINESS										
SUCCULENCE										
TOUGHNESS										
FIBROSITY										
OVERALL ACCEPTANCE										

1	Dislike extremely
2	Dislike very much
3	Dislike moderately
4	Dislike slightly
5	Neither like nor dislike
6	Like slightly
7	Like moderately
8	Like very much
9	Like extremely
10	excellent

3.3 Sterility test

3.3.1 isolation of microbes

The highest-scoring pouches from the sensory test were aseptically opened, and a sterile streaking loop of the samples was streaked on the agar using Chromocult Coliform Agar in the laminar flow to create a single colony on the plate according to Kamaruzzaman *et al.*, 2020). For one day, the samples were incubated at 37°C. After 24 hours, the agar was seen.

The colonies are counted after the plate has been incubated under the proper conditions for the bacterium. The colony counting for the spread, pour, or drop techniques is self-explanatory: count each colony dot once. On the back of the Petri dish, a marker can be used to point to each numbered colony.

3.3.2 Observation

The retort packaging was also examined to have the best quality packaging from cases such as bloated, leaking or the food spoilage.

3.4 Physio-chemical test

The physicochemical of the fillet and the paste are important to check before it was packet in the retort packaging. The quality of the samples was examined through three different test.

3.4.1 Proximate Analysis

The proximate analysis following Association of Official Agricultural Chemists (AOAC) method was performed on the raw tilapia fish, paste, fish and paste before and after undergo retort processing (selected based on outcomes from survey) and to determine the chemical composition. Proximate analysis determined the amount of dry matter, crude protein, crude fat, crude fibre, moisture content, and ash content in fish fillet in 50g of fish fillet with 50g of paste.

The purpose of proximate analysis is to identify the nutritional composition of fish fillets and pastes in two distinct mediums: raw mixed and cooked by thermal heat treatment. The fish fillet, paste, and combination were analysed for crude protein, fat, crude fibre, ash, and moisture. The dry matter was prepared ahead of time, and the electric oven was set at 120°C.

Crude Protein Determination (CP)

Kjeldahl method was used to measure the amount of nitrogen in the samples of the fish fillet, the paste and the mixture of the fillet and the paste. Amount of nitrogen then be used to calculate the crude protein content using formula as in Kjeldahl Method for Determining Nitrogen from Cole-Parmer, 2021. The digestion, distillation, and titration methods are the three main steps in the Kjeldahl process. The outcome will be timed by 6.25 after titration to convert the nitrogen to the protein content.

$$\%N = [(14 \times VA \times 0.1) \div (1000 \times 100)] \times 100$$

$$\text{Crude protein } (\%) = \text{Nitrogen } (\%) \times 6.25$$

(3.4.1)

The N is the crude protein value; VA is the volume of acid HCL used(ml).

Ether Extract Determination (EE)

Ether extract analysis is a technique for determining the number of fats and oils present in a substance. The coarse fat content of the fish fillet samples and the paste was determined using the Soxtec process. In this experiment, ST 255 Soxtec semi-automated solvent extraction system was used.

Data of weight from crucible before and after obtained from Soxlet process were used to calculate the percentage of crude fat using the following formula

$$Crude\ Fat(\%) = (Mass\ of\ Beaker + Fat) - (Mass\ of\ Beaker) Sample\ Mass \times 1001 \quad (3.4.1)$$

Crude Fibre Determination

After chemical digestion and solubilization of other components present, crude fibre is measured gravimetrically. After combustion, the fibre residual weight was adjusted for ash content. Using Fibretec^{TM} 8000 gives official method findings (ISO, AOAC), as well as the best fibre analysis solution for crude fibre, ADF, ADL, and NDF.

The Fibretec™ 8000 is a completely automated system that uses internally warmed chemicals that are added in a closed system to reduce contact with burning reagents. CF (%) was determined based on the following formula:

$$CF(\%) = \frac{(m_3 - m_1 - m_4 - m_5)}{m_2} \times 100 \quad (3.4.1)$$

Where m_1 – Fibre bag (g), m_2 - Initial sample weight (g), m_3 – Incinerating crucible and dried fibre bag after digestion (g), m_4 - Incinerating crucible and ash, m_5 – Blank value of the empty fibre bag (g).

$$\text{Blank value} = (m7 - m6) \quad (3.4.1)$$

Where m_6 – Incinerating crucible (g), m_7 – Incinerating crucible and ash of the empty fibre bag (g)

Ash Content Determination

Ash is the inorganic residue remaining after the ignition or complete oxidation of organic components in a food sample. The crucible was prepared and the calculation of ash are calculated after it was incinerated in the furnace.

Calculation of %Ash =

$$\text{Ash}(\%) = \frac{W3 - W1}{W2} \times 100 \quad (3.4.1)$$

Where W1 – Weight of empty crucible (g), W2 – Weight of sample (g), W3- Weight of crucible and ash (g)

3.4.2 Textural Profile Analysis (TPA)

The TPA approach was used to objectively test texture by compressing samples with a muscle texture analyzer (TA-XT Plus, Stable Micro Systems, UK) (John *et al.*, 2018). A 75 mm diameter cylindrical probe with a 50 N sensor was used as the load cell. The raw fillet and the mix between raw fillet and the paste were measured. Data of the hardness, cohesiveness and the springiness are recorded.

3.4.3 PH meter Test

pH measurements were carried out to observe the raw fish fillet and paste before mixture, after the mixture and after the heat treatment. pH test was carried out using digital pH meter.

3.4.4 Calorimeter Test

The colour of the homogenised material was examined using a spectrocolorimeter (Colourflex EZ, Hunter Associates Laboratory, Inc, Reston, VA) with diffuse 8° geometries and a D65/10° illuminant. A thin (1–1.5 mm) strip of fillet, a strip of paste, and a mixture of raw fillet and paste were collected, as well as the post-processing L*, a*, and b* values. For each steak, six readings were obtained, and the average results were determined. The CIELAB (L*, a*, b*) colour scale was used in the experiment. In this coordinate system, L* is a measure of a ’ample's lightness, ranging from 0 (black) to 100. (white). Color designations based on the chromaticity dimensions (a and b) are as follows: When a* is positive, greyness is zero, and greenness is negative; when b* is positive, greyness is zero, and blueness is negative, it measures yellowness, greyness, and blueness. Color saturation is indicated by higher a* and b* values.

3.5 Retort Preparation

The product was prepared to be made into ready to eat product.

3.5.1 Preparation of Retort Pouch

The fish fillets and paste will be wrapped in a laminated flexible pouch (4-ply), four-sided seal pouch composed of polyester (12m) for the outside layer, aluminium foil and nylon for the middle layer, and polypropylene for the final layer (70m). The pouches can hold between 150 and 250 grammes and were acquired from Hasratmurni Shop in Melaka, Malaysia. Internal burst strength for seal integrity (Duxbury *et al.* 1970), heat seal strength (ASTM 1973), tensile strength and elongation at break (IS: 2508 1984), overall migration residue (FDA 1983), and residual air as per Shappee and Werkowski

(1972) was used to determine the physical properties and suitability of pouches for food contact applications.

3.5.2 Retort Pouch Filling and Sealing

In the retort pouch, 505g of tilapia fillet pieces were packaged. Each bag was filled with a varied amount of paste (25g, 50g, 100g), resulting in a pack weight of 150-10 g. Care was made to avoid contamination of the seal area of the pouches. To optimise the F0 value at process temperature, thermal processing was conducted to the sealed pouches.

3.5.3 Retort Process

The pouches were hand filled with 50g fish fillet in each retort pouch with a varied volume of paste each treatment and sealed before being heat treated to the required F0 values. The ingredients were subsequently transformed into ready-to-eat meals. It was packaged in a no-stand aluminium pouch (13cmx16cm) that can hold 150g-180g of food. Before heat processing, they were sealed using an automatic continuous plastic bag heat sealing machine and sterilised in a small vertical hot water spray retort at 121°C for 15 minutes. Built with an automated cool air discharge system, automatic steam discharge after sterilisation, a door safety lock system, and an automatic shutoff with a buzzer reminder after sterilisation. During the sterilising cycle, the retort was set to steam/air mixture mode. During each process cycle, the temperature was maintained at 121.1 C with a steam pressure of 1.05 bar and an overpressure of 2.1 bar. The retort used a programmable controller to support manual control, which meant that the retort operation was done manually but with the help of discrete electronic programmable input detector controllers for temperature and pressure.

3.5.4 Cooling and Washing

The packaging then was let down to cool until it was alright to handle.

3.6 Statistical Analysis

The statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) software packages version 26. The data were collected in triplicate and given to a One-Way Analysis of Variance (ANOVA) using the'Tukey's HSD (honestly significant difference) test to look for differences in mean values, with a significance level of ($P<0.05$). Data presented as mean±SEM,

CHAPTER 4

RESULT AND DISCUSSION

4.1 Sensory Evaluation

Table 4.1: Sensory test result against 50 untrained panellists of students and staffs of University Malaysia Kelantan.

Parameter(%)	Groups			
	Treatment 1 (25% of paste)	**Treatment 2 (50% of paste)**	**Treatment 3 (100% of paste)**	**p-value**
Colour	6.80±0.28	7.58±0.21	7.44±0.28	0.08
Flavour	7.18±0.30	7.40±0.27	6.90±0.31	0.49
Chewiness	7.36±0.26	7.82±0.21	7.22±0.28	0.22
Succulence	7.44±0.27	7.32±0.27	7.38±0.28	0.95
Toughness	6.26±0.37	6.82±0.30	6.56±0.32	0.49
fibrosity	6.42±0.31	7.20±0.26	7.04±0.33	0.16
Overall acceptance	7.54±0.29	7.70±0.25	7.34±0.32	0.67

All traits measured on 10-point scale with 1 being least and 10 being the most.
* Each value is represented by the average ± standard error of scores given by 50 taste panel members. Means in a column with the same letters are not significantly different (P <0.05).

Table 4.1 shows the results of sensory evaluations of various treatments. In general, all of the samples scored well on all of the sensory measures tested. Treatment 3 was the only one that scored significantly lower in terms of flavour, chewiness, and overall acceptability. Treatment 1 had a colour intensity score of 6.80 since it only contained 25% paste. The lower colour score of the sample might be attributable to a lack of deeper colour when compared to two other treatments with more paste. Furthermore, there were no significant variations in the fish fillet products in terms of colour, flavour, chewiness, succulence, toughness, fibrosity, and overall acceptability. As a result, the tester concluded that the taste of all samples was comparable to that of typical commercial consumer items.

Treatment 2 (50% paste) got higher ratings in all metrics (except succulence), but no significant differences were found. Treatment 3 has the deepest colour among the treatments, which is white yellowness from the turmeric, which is more acceptable to the tester, but treatment 1 and 2 have a lighter colour due to paste shortage. Furthermore, because of the greater texture and flavour of these samples, overall acceptance for the sample of treatment 2 was the greatest, resulting in higher acceptability by the testers.

4.2 Sterility Test

During storage study different parameters like characteristics and isolation measurements were carried out after the thermal heat processed. Thermally processed fish fillet with paste were kept at room temperature (28 ±2^{o}c) for storage study after 24 h.

Throughout the storage time, all of the samples were examined for total plate count, but no microbial growth was discovered in any of them. It means that the microbes were completely eliminated by the heat procedure used to prepare in retort pouches. The sterility of the packaged product is also maintained during the storage duration thanks to the strong barrier qualities and integrity of the retort pouches utilised. After 24 hours, no leaking or ballooning of the pouch was noted. For ready-to-eat ginseng chicken porridge treated to F0 4 min and kept for 28 weeks, Jang and Lee (2012) found that no microbial growth was identified beyond the detection limit (1.0 log cfu/cm2). During the 180-day storage period, no microbiological growth was identified in retort pouch processed Chettinad chicken, according to Rajan *et al*. (2014).

4.3 Physico-Chemical Test

4.3.1 Proximate Analysis

Raw tilapia fillets had protein, fat, fibre, ash, and moisture concentrations of 5.00 percent, 2.00 percent, 1.67 percent, and 2.00 percent, respectively.

Table 4.2: Proximate composition of raw fish fillet, raw paste, raw fish mix with paste and retort fish mix with paste.

Parameter (%)	**Group**				
	Raw fish	**Raw paste**	**Non retort fish fillet with paste(NR-FFP)**	**Retort fillet with paste (R-FFP)**	**P- value**
Protein	5.00 ± 0.58^{b}	2.00 ± 0.58^{a}	8.00 ± 0.58^{c}	11.00 ± 0.58^{d}	0.00
Fat	2.00 ± 0.58^{a}	5.00 ± 0.58^{b}	7.33 ± 0.33^{c}	10.33 ± 0.33^{d}	0.00
Crude fibre	1.67 ± 0.33^{a}	4.67 ± 0.33^{b}	7.67 ± 0.33^{c}	10.67 ± 0.33^{d}	0.00
Ash	1.67 ± 0.33^{a}	4.67 ± 0.33^{b}	7.67 ± 0.33^{c}	10.67 ± 0.33^{d}	0.00
Moisture	2.00 ± 0.58^{a}	5.00 ± 0.58^{b}	8.00 ± 0.58^{c}	11.00 ± 0.58^{d}	0.00

When compared to the findings of Olopade *et al.* (2005), there was a little variation in the proximate composition of raw tilapia. Variations in protein, fat, fibre, ash, and moisture content within the same species have been observed to be related to size, sexual maturity, and feeding regime. (Love & Pearson, 1974; Børresen,1992; Shearer *et al.*, 1994; Huss, 1995).

Thermal heat frying was shown to have a significant effect on the proximate components of tilapia fish fillets ($P < 0.05$). After retort processing, the sample's protein, fibre, fat, ash, and moisture content rose. As a result of the coagulation of the crude protein, the protein content rose. Protein accounts for the majority of dry matter in fish, according to Steffens (2006).

4.3.2 Texture Profile Analysis (TPA)

Table 4.3: textural profile analysis, pH and calorimetry of raw fish, raw paste, raw fish mix paste and retort fish mix with paste.

Parameter (%)		Group			
		Raw Fish	**Non retort fish fillet with paste(NR-FFP)**	**Retort fillet with paste (R-FFP)**	**P-Value**
Texture profile analysis	**Hardness 1**	66.00±7.00	93.33±42.33	94.33±10.17	0.69
	Hardness 2	32.00±3.00	55.00±21.00	67.33±5.78	0.22
	Cohesiveness	0.30±0.17	0.17±0.17	0.31±0.50	0.46
	Springiness	0.81±0.33	0.78±0.12	0.60±0.11	0.30
	Chewiness	1.50	1.13±0.43	1.87±0.60	0.52

[A]Values are reported as means (average of triplicate trial± standard error); different small letters in a column and in each group of produced fish fillet/paste mean the values differ significantly at (p<0.05.)

Using TPA, the examination of the textural qualities of raw fish fillet, Non retort fish fillet with paste(NR-FFP) and retort fillet with paste (R-FFP) was continued, taking into account the above understanding of the topic. This textural profile study does not include paste. In comparison to before the retort process, the textural qualities of retort fillet with paste (R-FFP) comprising 50% paste acquire hardness, cohesiveness, springiness, and chewiness. The increase in hardness of raw fillet fish following the retort process is due to increased protein levels and moisture content, both of which impact the gelation and emulsification capacity of the formulation, according to the manufacturer (Pereira *et al*. 2011). It was also backed by a research by (Savadkoohi *et al*., 2014), which indicated that the increase in the outcome is due to the protein matrix chemically holding water and expanding when it comes into contact with water, resulting in texture and cohesiveness of the final product. It's worth noting that the textural features of meat emulsions are affected by other factors including protein, fat, and water content. Pectin may lead to an increase in shearing work value, whilst cellulose and lignin may impact the fillet's hardness and cohesiveness (Calvo *et al*., 2008). Thus, the presence of fibre (10.67%) and certain hydrocolloids (lignin and cellulose) in the paste might explain the increase in hardness of the Non retort fish fillet with paste(NR-FFP).

From raw fish to processed fish, the springiness of the outcome shows a decreasing tendency. Even though there is no substantial difference in the results for any of the metrics, the results for hardness1, hardness 2, chewiness, and cohesiveness all show varying degrees of promotion. Only the springiness revealed a decrease in the outcome.

4.3.3 pH test

This is most likely due to variables such as pH, the type of meat used, pre-treatments (cooling and grinding), components, additions, and spices.

Table 4.4: pH of raw fish, raw paste, raw fish mix paste and retort fish mix with paste.

Sample Group	**pH**
Raw Fish	1.33 ± 0.33^{a}
Raw Paste	4.67 ± 0.33^{ab}
Raw Fish Mix Paste	6.34 ± 2.19^{ab}
Retort Fish Mix Paste	9.33 ± 0.88^{b}
P-Value	0.01

[A]Values are reported as means (Mean ± SEM); different small letters in a column and in each group of produced fish fillet/paste mean the values differ significantly at ($p < 0.05$).

The treatments had a substantial ($p<0.05$) impact on the pH readings; the pH of raw fish product is 1.33. The maximum pH level for the internal portion of fresh fish was set at 6.5 by the Official Regulations on Industrial Sanitation and Inspection of Animal Products – RIISPOA (BRASIL, 2002).

4.3.4 Calorimeter

Table 4.5: Table of calorimetric tested shown L*, a* and b*.

Parameter (%)		Group				
		Raw Fish	**Raw Paste**	**Raw Fish Mix Paste**	**Retort Fish Mix Paste**	**P-Value**
Colorimeric	**L***	50.71±0.31^{b}	32.22±0.88^{a}	39.05±1.66^{ab}	45.80±5.08^{b}	0.01
	a*	0.54±0.93^{a}	4.46±0.17a^{b}	1.65±1.87a^{b}	5.78±0.90^{b}	0.04
	b*	5.99±0.17^{a}	12.69±0.56^{b}	12.19±0.97^{b}	19.19±2.37^{c}	0.00

^{A}Values are reported as means (average of triplicate trial) ± standard error; different small letters in a column and in each group of produced fish fillet/paste mean the values differ significantly at p b 0.05; a*: −60 = green and +60 = red; b*: −60 = blue and +60 = yellow; L*: 0 = black and 100 = white; h°: Calculated as tan−1 (b*/a*): 90° = yellow, 180° =green and 0° = red; C*: calculated as (a*2 + b*2)0.5: distance from the coordinates in the origin to the determined colour point.

The effect of paste on the colour values of fish fillets is shown in Table 5. The most informative metrics for colour shifts are perceived lightness (L*) and redness (a*) (Mielnik & Slinde, 1983). Heat treatment impacted lightness (L*), redness (a*), and yellowness (b*) significantly.

Color data from the initial sample before and after processing was analysed, including L* (darkness to lightness), a* (redness to greenness), and b* (blue to yellowness). The L* values of the samples increased slightly, indicating that the lightness of the samples has changed toward lighter; the a* values also showed a rise in red colour, but still in green because the data did not exceed 60.00; and the b* data showed the result rise a little as the heat treatment influenced the blue colour to yellowness, but the cooking process made the fish fillet whiter. All of the results shown here were statistically significant (P <0.05).

The element in the paste, such as the red colour in chilli, which originates from the carotenoids capsanthin and capsorubin, must effect the redness (a*) in the retort result of retort fillet with paste (R-FFP). It could also be caused by the red pigment produced by prolonged heat treatment, no enzymatic browning, or Maillard reactions. -carotene and violaxanthin are responsible for the yellow-orange colour. According to a study, the addition of dietary fibres alters the quality of meat products' primary qualities, the most important of which are colour and scent (Hughes *et al.*, 1997). The retort mix paste's colour might be related to the low fat content (10.33) and high water content (11.00), which result in greater a* values and lower L* values (Gimeno *et al*, 2000).

A small increase in yellowness (b*) was noticed in raw fish mixed with paste when the amount of paste was increased. With a 50% rise in paste, this trend also stayed consistent in lightness (L*). Yellowness index scores ranged from 47 to 49. Increased clarity in terms of cleanness or clarity is indicated by a reduction in yellowness levels (Bozkurt & Bayram, 2006). The yellowness of raw fish increased as the amount of paste was increased in this investigation, showing that the flesh of the fish fillet got more yellowish after the paste was added. Curcumin, the component of turmeric (Curcuma longa) that gives the spice its bright yellow colour, is present in the paste's constituents such as turmeric. However, other investigations have found that high temperatures, such as those used in blanching, cause curcumin to be thermally degraded, indicating a direct effect of prolonged boiling, sun drying, and sliced rhizome (Raza *et al.*, 2018).

CHAPTER 5

CONCLUSION AND RECOMMENDATION

Finding from the sensory evaluation test carried out in the present study suggests that treatment with 50% paste is the most preferable among all treatments. Meanwhile, physical properties show a growing tendency with heat treatment. The pH in the pouch is likewise safe for consumption by consumers. For processing and storing this product, indigenously designed three-layer retort pouches were proven to be appropriate for food contact application.

To conclude, the acceptance of people towards different ratio of paste and fish are by 50:50 ration. The effect of retort process on physio-chemical properties of tilapia fillet with paste show that the increasing trend in proximate analysis, the colour test, pH and the texture and lastly, the ability of retort processing in eliminating microbes in tilapia fillet with paste are efficient as it helps to provide longer shelf life to the product. I recommend a new sample such as chicken or beef to be done for future study.

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Appendix A

Descriptive Analysis And Test Of Homogeneity Of Variance Of Sensory Evaluation Via SPSS

Descriptives

		N	Mean	Std. Deviation	Std. Error
COLOUR	TREATMENT 1	50	6.8000	2.00000	.28284
	TREATMENT 2	50	7.5800	1.49952	.21206
	TREATMENT 3	50	7.4400	2.01180	.28451
	Total	150	7.2733	1.87135	.15280
FLAVOUR	TREATMENT 1	50	7.1800	2.15416	.30464
	TREATMENT 2	50	7.4000	1.90595	.26954
	TREATMENT 3	50	6.9000	2.20621	.31200
	Total	150	7.1600	2.08890	.17056
CHEWINESS	TREATMENT 1	50	7.3600	1.81558	.25676
	TREATMENT 2	50	7.8200	1.49407	.21129
	TREATMENT 3	50	7.2200	2.00296	.28326
	Total	150	7.4667	1.78985	.14614
SUCCULENCE	TREATMENT 1	50	7.4400	1.93949	.27429
	TREATMENT 2	50	7.3200	1.87834	.26564
	TREATMENT 3	50	7.3800	1.95761	.27685
	Total	150	7.3800	1.91311	.15620
TOUGHNESS	TREATMENT 1	50	6.2600	2.60149	.36791
	TREATMENT 2	50	6.8200	2.15416	.30464
	TREATMENT 3	50	6.5600	2.26021	.31964
	Total	150	6.5467	2.34188	.19121
FIBROSITY	TREATMENT 1	50	6.4200	2.21396	.31310
	TREATMENT 2	50	7.2000	1.80702	.25555
	TREATMENT 3	50	7.0400	2.31199	.32697
	Total	150	6.8867	2.13484	.17431
OVERALL_ACCEPTANCE	TREATMENT 1	50	7.5400	2.02243	.28601
	TREATMENT 2	50	7.7000	1.74087	.24620

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
COLOUR	Between Groups	17.293	2	8.647	2.519	.084
	Within Groups	504.500	147	3.432		
	Total	521.793	149			
FLAVOUR	Between Groups	6.280	2	3.140	.717	.490
	Within Groups	643.880	147	4.380		
	Total	650.160	149			
CHEWINESS	Between Groups	9.853	2	4.927	1.549	.216
	Within Groups	467.480	147	3.180		
	Total	477.333	149			
SUCCULENCE	Between Groups	.360	2	.180	.049	.953
	Within Groups	544.980	147	3.707		
	Total	545.340	149			
TOUGHNESS	Between Groups	7.853	2	3.927	.713	.492
	Within Groups	809.320	147	5.506		
	Total	817.173	149			
FIBROSITY	Between Groups	16.973	2	8.487	1.884	.156
	Within Groups	662.100	147	4.504		
	Total	679.073	149			
OVERALL_ACCEPTANCE	Between Groups	3.253	2	1.627	.401	.670
	Within Groups	596.140	147	4.055		
	Total	599.393	149			

Appendix B

Descriptive Analysis And Test Of Homogeneity Of Variance Of physicochemical Via SPSS

Descriptives

		N	Mean	Std. Deviation	Std. Error
CRUDE_PROTEIN	RAW PASTE	3	2.0000	1.00000	.57735
	RAW FISH	3	5.0000	1.00000	.57735
	RAW FISH PASTE	3	8.0000	1.00000	.57735
	RETORT FISH PASTE	3	11.0000	1.00000	.57735
	Total	12	6.5000	3.60555	1.04083
CRUDE_FIBRE	RAW PASTE	3	4.6667	.57735	.33333
	RAW FISH	3	1.6667	.57735	.33333
	RAW FISH PASTE	3	7.6667	.57735	.33333
	RETORT FISH PASTE	3	10.6667	.57735	.33333
	Total	12	6.1667	3.53768	1.02124
CRUDE_FAT	RAW PASTE	3	5.0000	1.00000	.57735
	RAW FISH	3	2.0000	1.00000	.57735
	RAW FISH PASTE	3	7.3333	.57735	.33333
	RETORT FISH PASTE	3	10.3333	.57735	.33333
	Total	12	6.1667	3.27062	.94415
ASH_CONTENT	RAW PASTE	3	4.6667	.57735	.33333
	RAW FISH	3	1.6667	.57735	.33333
	RAW FISH PASTE	3	7.6667	.57735	.33333
	RETORT FISH PASTE	3	10.6667	.57735	.33333
	Total	12	6.1667	3.53768	1.02124
MOISTURE_CONTENT	RAW PASTE	3	5.0000	1.00000	.57735
	RAW FISH	3	2.0000	1.00000	.57735
	RAW FISH PASTE	3	8.0000	1.00000	.57735

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
CRUDE_PROTEIN	Between Groups	135.000	3	45.000	45.000	.000
	Within Groups	8.000	8	1.000		
	Total	143.000	11			
CRUDE_FIBRE	Between Groups	135.000	3	45.000	135.000	.000
	Within Groups	2.667	8	.333		
	Total	137.667	11			
CRUDE_FAT	Between Groups	112.333	3	37.444	56.167	.000
	Within Groups	5.333	8	.667		
	Total	117.667	11			
ASH_CONTENT	Between Groups	135.000	3	45.000	135.000	.000
	Within Groups	2.667	8	.333		
	Total	137.667	11			
MOISTURE_CONTENT	Between Groups	135.000	3	45.000	45.000	.000
	Within Groups	8.000	8	1.000		
	Total	143.000	11			

Descriptives

		N	Mean	Std. Deviation	Std. Error
hardness1	fish fillet	3	66.0000	12.12436	7.00000
	nffr	3	93.3333	73.32348	42.33333
	ffr	3	94.3333	17.61628	10.17076
	Total	9	84.5556	40.64822	13.54941
hardness2	fish fillet	3	32.0000	5.19615	3.00000
	nffr	3	55.0000	36.37307	21.00000
	ffr	3	67.3333	10.01665	5.78312
	Total	9	51.4444	24.57189	8.19063
cohesiveness	fish fillet	3	.2967	.02887	.01667
	nffr	3	.1767	.02887	.01667
	ffr	3	.3133	.08737	.05044
	Total	9	.2622	.08059	.02686
springiness	fish fillet	3	.8133	.05774	.03333
	nffr	3	.7833	.20207	.11667
	ffr	3	.6033	.18583	.10729
	Total	9	.7333	.17132	.05711
chewiness	fish fillet	3	1.5000	.00000	.00000
	nffr	3	1.1333	.75056	.43333
	ffr	3	1.8667	1.04083	.60093
	Total	9	1.5000	.71589	.23863

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
hardness1	Between Groups	1550.889	2	775.444	.399	.688
	Within Groups	11667.333	6	1944.556		
	Total	13218.222	8			
hardness2	Between Groups	1929.556	2	964.778	1.996	.217
	Within Groups	2900.667	6	483.444		
	Total	4830.222	8			
cohesiveness	Between Groups	.033	2	.017	5.380	.046
	Within Groups	.019	6	.003		
	Total	.052	8			
springiness	Between Groups	.077	2	.039	1.475	.301
	Within Groups	.157	6	.026		
	Total	.235	8			
chewiness	Between Groups	.807	2	.403	.735	.518
	Within Groups	3.293	6	.549		
	Total	4.100	8			

Descriptives

		N	Mean	Std. Deviation	Std. Error
PH_METER	RAW FISH	3	1.3333	.57735	.33333
	RAW PASTE	3	4.6667	.57735	.33333
	RAW FISH PASTE	3	6.3333	3.78594	2.18581
	RETORT FISH PASTE	3	9.3333	1.52753	.88192
	Total	12	5.4167	3.50216	1.01099

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
PH_METER	Between Groups	100.250	3	33.417	7.712	.010
	Within Groups	34.667	8	4.333		
	Total	134.917	11			

Descriptives

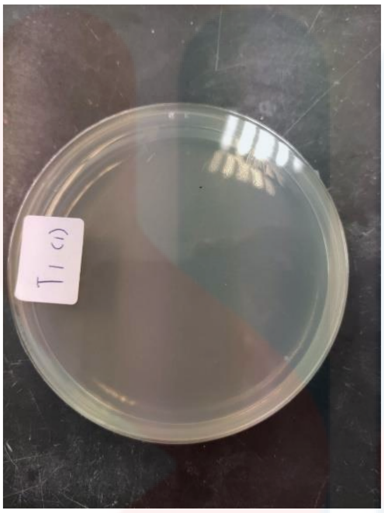
		N	Mean	Std. Deviation	Std. Error	95% Confidence ... Lower Bound
L	raw fish	3	50.7067	.57012	.32916	49.2904
	raw paste	3	32.2167	1.53106	.88396	28.4133
	raw fish paste	3	39.0500	2.86658	1.65502	31.9290
	retort fish mix paste	3	45.7967	8.79088	5.07542	23.9589
	Total	12	41.9425	8.31320	2.39982	36.6605
a	raw fish	3	.5367	1.61779	.93403	-3.4821
	raw paste	3	4.4600	.28827	.16643	3.7439
	raw fish paste	3	1.6533	3.24323	1.87248	-6.4033
	retort fish mix paste	3	5.7833	1.55725	.89908	1.9149
	Total	12	3.1083	2.77041	.79975	1.3481
b	raw fish	3	5.9867	.30238	.17458	5.2355
	raw paste	3	12.6933	.96645	.55798	10.2925
	raw fish paste	3	12.1867	1.67840	.96903	8.0173
	retort fish mix paste	3	19.1867	4.11308	2.37469	8.9692
	Total	12	12.5133	5.25123	1.51590	9.1769

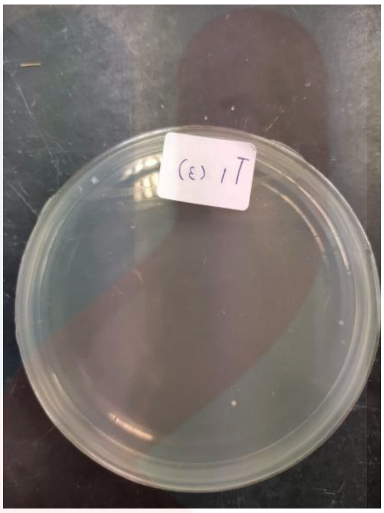
ANOVA

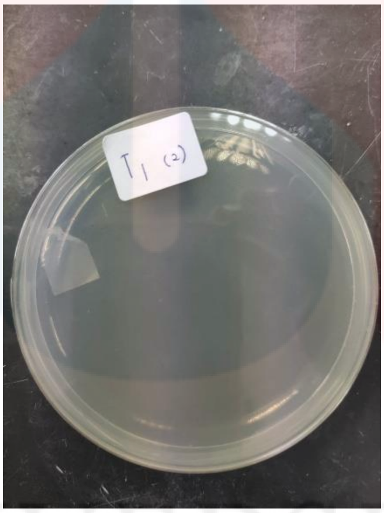
		Sum of Squares	df	Mean Square	F	Sig.
L	Between Groups	583.871	3	194.624	8.830	.006
	Within Groups	176.332	8	22.042		
	Total	760.203	11			
a	Between Groups	53.139	3	17.713	4.529	.039
	Within Groups	31.288	8	3.911		
	Total	84.427	11			
b	Between Groups	261.810	3	87.270	16.815	.001
	Within Groups	41.520	8	5.190		
	Total	303.329	11			

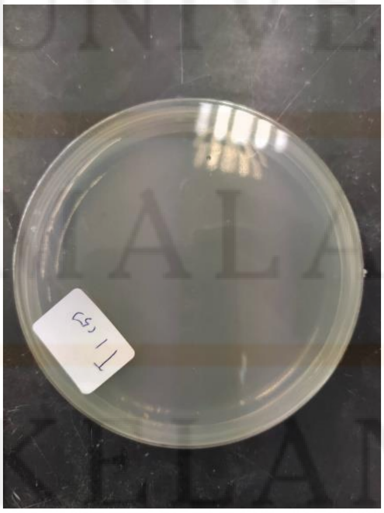
Appendix C

Picture of Microbial Count on Nutrient Agar Plate.









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