Textural and sensory characteristics of retort-processed freshwater prawn, *Macrobrachium rosenbergii* in paste medium.

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DECLARATION

I declare that the work embodied in this thesis is from my own research except for the content that have been cited and summarised and I have made reference for every source.

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Textural and sensory characteristics of retort-processed freshwater prawn, *Macrobrachium rosenbergii* in paste medium.

ABSTRACT

This study aims to determine the textural and sensory characteristics of retort-processed freshwater prawn, *Macrobrachium rosenbergii*, in paste medium. The types of packaging materials and methods were also determined to be suitable for low-cost packaging without sacrificing the quality of the meat. The *M. rosenbergii* was mixed with different three treatments of paste seafood containing about 25%, 50%, and 100% in different pouches, that is, Treatment 1, Treatment 2, and Treatment 3, which were packed using retort packaging, which went through a process of cooking, filling, and sterilization. Then, after the packaging is done, the effects of the packaging material and method on the *M. rosenbergii* will be determined using proximate analysis. Besides, the texture and sensory tests were also being carried out using physical analysis, proximate analysis, sensory test evaluation and statistical analysis the one-way ANOVA. Outcomes from the present study reveal that the retort packaging will provide an adequate shelf life for the prawn and maintain the quality of the prawn during its stay in the freezer. Finally, the best prawn in paste medium is T 1, because it has the highest protein content, the pouch is in good condition, and the taste is very delicious.

Keywords:

Macrobrachium rosenbergii, retort processed, ready-to-eat, shelf life, seafood paste, sensory test

Ciri tekstur dan rasa udang air tawar yang diproses mengunakan retort, *Macrobrachium rosenbergii* dalam medium pes.

ABSTRAK

Kajian ini bertujuan untuk menentukan ciri tekstur dan deria udang air tawar yang diproses retort, Macrobrachium rosenbergii, dalam medium pes. Jenis bahan dan kaedah pembungkusan juga ditentukan sesuai untuk pembungkusan kos rendah tanpa mengorbankan kualiti daging. M. rosenbergii dicampur dengan tiga rawatan berbeza bagi pes makanan laut yang mengandungi kira-kira 25%, 50% dan 100% dalam kantung yang berbeza, iaitu Rawatan 1, Rawatan 2 dan Rawatan 3, yang dibungkus menggunakan pembungkusan retort, yang digunakan melalui proses memasak, mengisi, dan pensterilan. Kemudian, selepas pembungkusan dilakukan, kesan bahan dan kaedah pembungkusan terhadap M. rosenbergii akan ditentukan menggunakan analisis proksimat. Selain itu, ujian tekstur dan rasa dijalankan. Hasil daripada kajian ini mendedahkan bahawa pembungkusan retort akan memberikan jangka hayat yang mencukupi untuk udang dan mengekalkan kualiti udang semasa berada di dalam peti sejuk. Akhir sekali, udang dalam medium pes terbaik ialah T 1, kerana ia mempunyai kandungan protein yang paling tinggi, uncangnya dalam keadaan baik, dan rasanya sangat lazat.

Kata kunci:

Macrobrachium rosenbergii, diproses retort, sedia untuk dimakan, jangka hayat, pes makanan laut

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LIST OF SYMBOLS

		Pages
%	Percentage	14,18,25,26,27,28,29,
^{c}C	Degree Celsius	27,32
g	gram	19,20
kg	kilogram	17
mL	Millilitres	25,26,27,28,29,30
h	Hour	26,27
min	minute	25,26,27,28,29,30

LIST OF ABBREVIATIONS

		Pages
CP	Crude protein	25
RTE	Ready to eat	1,2,3,4
FAO	Food and Agriculture Organization	1
FCR	Feed conversion ratio	13
TPA	Textural profile analysis	23
H_2SO_4	Sulphuric Acid	25
H_3BO_3	Boric Acid	25
$a*$	Red/Green Value	43,44,53,54
$b*$	Blue/Yellow Value	43,44,53,54
$L*$	Lightness Value	43,44,53,54
$CuSO_4$	Copper sulphate	25
K_2SO_4	Potassium sulphate	25

CHAPTER 1

INTRODUCTION

1.1 Background of research

There been are noticeable changes in develop countries over the last few decades in the number of people consuming ready-to-eat (RTE) items. RTE foods are foods that have not been processed or prepared in any way. The foods are like the traditionally or industrially processing food, packaged or unpackaged, and is made up of mostly goods purchased from a public dispenser and consumers immediately or later (FAO and WHO, 2004; Makinde et al., 2020). Ready to Eat foods is cooking the meat and poultry, cold vegetables dishes in sauce, and fried rice, is immensely famous as the designed to be eaten quickly (Yu et al., 2020). Because of lifestyles today, indeed a higher need for processing food products and is now a high demanding such as the convenience foods (Brunner et al., 2010). Next, the increased numbers of urban populations are now also contributing to an increase in demanding for products and services associated the fasting-paced city live, particularly products the convenient and time-saving. In addition, serve consumer demand, a growing the number of the retails food outlets serve fasting and convenient food (Osman et al., 2014).

The factors influence that is the demand for ready-to-eat meals, including the population aging, change in the family structures, women's participation in workforce, longer working hours, consumer’s prosperity, a desire to move toward healthier food, individualism, a decline in cooking skills, and a desiring to spend less time and effort on meal-related activities such as shopping, preparing, and cleaning foods. Other significant influences the family size, income level, and work timetable (Siekierski et al., 2013). However, as the consumption of RTE foods grows, public health challenges and other challenges surface. The item RTE foods for example meat, poultry,the fried rice, and noodles has linked to many food poisoning outbreaks in Malaysia. (Lee et al. 2017). In Malaysia, there were 49.79 per 100,000 people incidents of food poisoning and outbreaks in academic institutions accounted for almost 43% of all foodborne poisoning incidents. In most cases, the contamination was caused by inappropriate storages, an unhygienic food preparation place, unhygienic personnel, or unsafe food handling techniques (Soon et al., 2011).

The problem is due to a lacking of consumer knowledge; to what extending are consumers awareness of food safety and support its developments and implementations in food industry. Previous research indicates the consumers' food safety attitudes, attitudes, and knowledge can influence practises and behaviours, this helping the resolution of foodborne illness issues (Beier et al., 2004; Bhat and Gómez-López, 2014). That food safety protocols are being updated, federal inspections are now being performed, and regulatory oversight has been performed (Fleet and Fleet, 2009). Next, understanding the consumers' attitudes and understanding of various foods safety issueless is responsible to effective food safety policy developments and implementations, as well as risk communication (Frewer et al., 2007).

The advantages of ready-to-eat foods are that they are simple alternatives to traditional meals that may be consumed at any time for any meal. And, as the title suggests, it offers consumers the ultimate convenience. It saves consumers at least 50% of their time during the whole food preparation process, so it needs a small effort. It's literally just a matter of heating up their food until it's ready to eat. As a result, manufacturers have invested resources in developing innovative products and providing variety in the market to capture demand and, as a result, get a higher market share (Cheah,C et al,2021). To determine study, the textural and sensory characteristics between retort processed and non-retort of freshwater prawn, *M. rosenbergii* with paste seafood and can improved the quality and taste of the textural and sensory characteristics of retort processed and non-retort of freshwater prawn, *M. rosenbergii* with paste seafood.

2.2 Problem Statement

In Malaysia, the market for RTE food is growing and has become a significant contributor to the regional food industry's gross domestic product. Several factors are lack of knowledge about the items and their nutritional value has raised health concerns and, as a result, has influenced people's RTE food purchase decisions, despite the relatively high prices (Selvarajn et al ,2012). There was no prior research that attempted to clarify the relationship between personal motivations, nutritional information interest, and RTE food purchase intention among Malaysian urban residents.

Because consumers that lack confidence are much less likely to support their own opinions and are much more likely to establish their decision on buying the RTE product (Aaron et al., 2000), this stud show the truth about Malaysian consumers' tastes before buy the RTE foods. Meanwhile, an inadequate amount of paste will also reduce the taste of the prawn and might also reduce its shelf life.

1.3 Objectives

The specific objective of this study are as follow:

i. To investigate the textural characteristics of retort-processed freshwater prawn, *M. rosenbergii* in paste medium.

ii. To determine the sensory characteristics of retort-processed freshwater prawn, *M. rosenbergii* in paste medium.

1.4 Hypothesis

- H_o: There is no significant between of retort and non-retort freshwater prawn, *M, rosenbergii* with paste medium.
- $H_{1:}$ There is significant between the textural and sensory characteristics of retort and non-retort freshwater prawn *M, rosenbergii* in paste medium.

1.5 Scope of The Study

The present studies were carried out to determine quality of seafood product that undergo retort processing as a preservation method. The optimum ratio of giant freshwater prawn and paste was determined and quality of the product in terms of physics-chemical characteristics was determine. Lastly, sterilization test was also investigated to determine the ability of retort processing to eliminate bacteria that can caused deterioration in food product. The methods will be used to analyse the portion, and the packaging method is physical analysis, proximate analysis, sensory test evaluation and statistical analysis using ANOVA.

1.6. Significance of Study

Findings form the present study contributes to an establishment of processing method for production of retort-processed giant freshwater prawn to maintain high quality and freshness of serving good prawn meat. Knowledge on how to add value to the aquaculture product will helps to expand the aquaculture industry by producing a high quality aquaculture product.

CHAPTER 2

LITERATURE REVIEW

2.1 General Introduction of *Macrobrachium rosenbergii*

The giant freshwater prawn or scientifically name known as the *Macrobrachium rosenbergii* can be found throughout at the tropical and subtropical place of the Indo-Pacific region, from India to Southeast Asia and Northern Australia. According to H.Motoh and Kuronuma (2012) the giant freshwater prawn have introduced to parts of Africa, Thailand, China, Japan, New Zealand, the Americas and the Caribbean. *M. rosenbergii* considered as successful aquaculture species is due to rapid growth rate and also due to its large size which can up to 200 mm.

Giant freshwater prawn has four stages in the life cycle which are egg, larva, juvenile and adult. Just like other crustaceans, they undergo several mouthing stages which depend on the environment, temperature and food availability. *M. rosenbergii* larvae hatch during night time, and even though it hatches in freshwater, the survival rate will be low because they require blackish water within two or three days to survive at this stage (Rafiqul,et al, 1993). Larvae generally consume a zooplankton, the small insects and have larvae of other aquatic invertebrates. The hatchery the larvae takes a minimum of 26 days to metamorphose into post larvae (PL). Normal habitat of PL is freshwater but it also be tolerating a wide range of salinity (Chowdhury and Bhattacharjee et al,2000). They becoming benthics and migrated upstreams for saline condition to completing the life cycles in freshwater. Table 2.1 shows the taxonomy of *M. rosenbergii*.

Table 2.1: Taxonomy of *M. rosenbergii*

Kingdom	**Animalia**
Phylum	Arthropoda
Class	Malacostraca
Order	Decapoda
family	Palaemonidea
Genus	Macrobrachium
Species	*Macrobrachium resenbergii*

(De Man, 1879)

2.2 Life cycle of *M.rosenbergii*

Male *M. rosenbergii* will deposit the spermtophores at underside the female's thorax between the walkings egg. Female will extrude the egg passes through the spermatophores. Then, female will carry of fertilized egg until hatches, at time varying but the generally less than the three weeks. The females lay of 10,000 – 50,000 eggs up to five times per years. Therefore, the egg hatching zoeae, the first larval stages of crustacean. They go trough's several the larval stages before metamorphosing into the postlarvae. At the stage is an 0.28 – 0.39 in (7.1-9.9 mm) long and resemble adult. The metamorphosis usually takes place about 32 to 35 days after hatching. The postlarvae migrated back into the fresh water.

2.3 Production of the *M. rosenbergii* culture

At Malaysia, giant freshwater prawn *Macrobrachium rosenbergii* is become the increasing the important target the species and culture, is considered the potential the raise income among impoverished farmers. Malaysia have been higher potential for aquaculture development to the country's favourable condition the term natural the habitat such as pond, river, lakes, estuaries and coastal areas. Although, aquaculture represents about the 20% of the total freshwater prawn at Malaysia. The total aquaculture production in Malaysia is rose steadily since 1980 and reaches an output of 1.69 million in 2017. The main species with the higher production value produce by the Malaysia aquaculture sector in 2018 was the White shrimp (*Penaeus vannamei*) 36.007 tan, Giant tiger prawn (*Penaeus monodon*) 9906 tan and Tilapia (*Orechromis spp*.) 31.766 tan (Food and Agriculture of the United Nation, FAO 2020c.). As an outcome, aquaculture, together with the fisheries sector, employment more than 140,000 people in 2017 (Hirschmann et al ,2019). The number and production of feed mills increasing in 2015 comparing to the five years ago. Until recently, lack of a stable nursery of PL and feed had been an important obstacle to the further expansion and development of *M. rosenbergii* culture in Malaysia.

2.4 Nutrition requirement of *M. rosenbergii*

The lack of nutrient particularly during early development stages will result inability to produce amounts of digestive enzyme (New & Valenti, 2010). Artemia nauplii has been shown the effective formulated diet *for M. rosenbergii* larvae. When larvae reach stage IV, they may eat both living and inert substances, but only at later stages. After larvae reach PL, they will migrate to saline water to freshwater such as green water. This water are algae rich and zooplankton can be used to rearing the PL (Ali, 2018).

According to Mitra, Chattopadhyay and Mukhopadhyay (2005), suitable amount of protein and amino acid for *M. rosenbergii* that grow in clear water system are 25-40% which similar to other crustacean and fish species. The amino acid provides the protein value in the feed formulation. Dietary carbohydrate acts as an energy source for prawn. Unsaturated fatty acid, HUFA (n-3 and n-6 HUFAs) have are highly required in small quantity to help to increase the weight gain and feed efficiency. As for dietary cholesterol, approximately 0.3-0.6% are essential for the growth and survival of prawn. For broodstock diet, of the low level of dietary cholesterol may affect the egg quality which resulted in poor quality of seed being produced. Vitamin helps in the growth and maintain proper health condition. It also might improve the quality of the larval including tolerance to ammonia stress. Meanwhile, information about mineral requirement for prawn is limited. Mitra, Chattopadhyay and Mukhopadhyay (2005) stated that supplying the calcium mineral might improve the growth of the *M. rosenbergii*.

2.5 Feed and feeding of *M. rosenbergii*

During early larval stage, *M. rosenbergii* larvae are extremely fragile, very small, and only depend on their partially developed system. Thus, the type of feed that can be fed to larvae is are limited. According to New, Valenti, Tidwell, D'Abramo, and Kutty (2010), *M. rosenbergii* larvae have an undeveloped gut until they reach larval stage V to VI. Therefore, they cannot be fed and digest artificial diets during their early stage. During the first larval stages, *M. rosenbergii* is carnivorous and being fed with live feed such as zooplankton, until larval stage V to VI. Larval stage VII and onward, the larvae started to become more omnivorous where they fed on a variety of feed including plant material and other invertebrates.

Due to their extremely fragile physical, *M. rosenbergii* larvae are not a good hunter and only capture nearby feed. The live feed will move vigorously inside the water so that they will not be captured, thus it will result in the larvae to move rapidly to chase the live feed. Due to this, it can damage the fragile larvae. Besides that, size of the live feed or preying also an importance characteristic of larvae feed. The size of the prey is not bigger compared to *M. rosenbergii* larvae. Therefore, a newly hatched Artemia nauplii are usually given to larvae during first feeding (stage II/III) (New M. B., Valenti, Tidwell et al , 2010). The table 2.5 shows the nutrient requirement of *M. rosenbergii*.

Table 2.5: Nutrient requirement of *M. rosenbergii*

Nutrient	**Growth stages**	**Requirement**
Protein (%)	Broodstock	38-40
	Juveniles (2^{nd}-4^{th} month)	35-37
	Adult (5^{th}-6^{th} month)	28-30
Carbohydrate (%)	For all stages	25-35
Lipid, including phospholipids (%)	For all stages	3-7
Highly unsaturated fatty acid (%)	For all stages	> 0.08
Cholesterol (%)	For all stages	0.5-06
Vitamin C (mg/kg)	Grow out	100
Calcium/Phosphorus	Grow out	1.5-2.0:1
Zn (mg/kg)	Grow out	90
Other mineral	Grow out	Quantitative requirement
	-	Not yet know
Energy	Broodstock	3.7-4.0 kcal/g feed
	Other stages	2.9-3.2 kcal/g feed

Source: Mitra Gopa *et al*. 2005

Next, feed the giant freshwater prawn needs the water stable, nutritionally well- balanced and formulated feed to make sure the *M. rosenbergii* grow fast and health. The nutrition of the *M. rosenbergii* has increasing in the year because help the rapid growth of *M. rosenbergii*. The *M. rosenbergii* at stage larvae needed the high protein and lipid to grow out the giant freshwater prawn. The *M. rosenbergii* need the protein for growth and maintenance on the component in a diet. The important to giant freshwater prawn farming needed know the knowledge about the optimum level protein to reducing the cost and the water pollution at the farm.

M. rosenbergii is the natural food such as zooplankton, and oligochaete worms playing some importance roles the nutrition's of *M. rosenbergii's* raised in ponds. And juveniles weighing more than 2 grams will eat live zooplankton. Prawns eat earthworms and insect larvae as well as other natural foods. In processing of *M. rosenbergii* increasing macroinvertebrate production in ponds is critical because it improves feed quality significantly. When the biomass in ponds grows to the animals grow, though, it is critical to use high-quality feeds. Furthermore, using feeds results in more consistent development of big prawns (Tidwell et al. 2004).

The feed ingredient of *M. rosenbergii* is a prawn's head meal, chicken's offal, clam meat, silk worm pupae, meat and bone meal, fish meal, crustacean meal, squid meal and mussel meat meal is used to make the feed of prawn. The types of cereal are cereal seeds, oil seed cakes (ground almond oil cake, soybean cake, sunflower oil cake), rice bran, and a variety of other animal husbandry and agricultural by-products have also been used in research diets. Many of the ingredients are also used in commercial and on-farm feeds produced in India. Animal protein sources, such as mussel meat meal, squid meal, shrimp meal, fishmeal, and earthworm meal, provide better to growth, moulting the frequency, and survival than plant protein sources, such as various oil seed cakes. Eating prawn meal as a protein substitute rather than mussel meat meal or a 1:1 mix of prawn's meal and mussel's meat meal results is the best growth production with the lowest feed conversion ratio (FCR) and highest protein efficiency ratio in feed. Meat and bone meal, as well as squall meal, can be substituted for fishmeal's in the preparations of effective prawn diets. By-products such as the soybean meal and distillers' can have used to partly or fully substitute fishmeal in diets. The other products (moist pressed brewers' grains, corn silage, beef liver, citrus flesh, peeled sweet potatoes, frozen peeled bananas, turnip greens, and carrot tops) can using in prawn diets more traditional animals feed ingredient.

The feed recipe was formulated using locally ingredients including groundnuts oil cake, fish's meal, soybeans meal, rice bran, and vitamin and mineral premix. The use of chemo attractants such as taurine, betaine, glycine, and proline in juvenile diets increases voluntary fed intakes and development. The betaine applied to water has shown to cause a bursting in food seeking activity, which leads to increased consumption and a 17 percent rise in prawn development at juvenile levels. Compared with the other biogenic amines such as putrescine, pheromones (crab urine and freshwater prawn green gland extracts), and squid extracts, cadaverine at 0.2 percent inclusion was the most effective attractants.

2.6 Retort pouch packaging

The flexible container's content then has superior in barriers properties for are long shelf life of the product, sealing integrity, hardness, puncture resistance, and thermal processing rigor. Any product that is usually packed in cans or glass will generally was packaging in flexible containers. The retort pouches are a semi-rigid, lightweight, and leak-proof packing solution made of heat resistant laminated plastic that can stand temperatures of up to 250ºc. The heat-resistant properties of the pouch allow for the sterile packing of a wide range of food items, making it the perfect packaging choice for secure, frozen, and pre-packaged food.

Retort pouch has a four layers, is FDA certified, and has been sterilised to improve the packaging's longevity. The first layer is propylene. It offers resilience and stability when acting as a heat seal surface. The second layer is nylon. This layer gives of pouch its abrasion-resistant feature. The third layer is aluminium Foil. Aluminium foil can help to the shelf life of a product by acting as a shield against light, fumes, microorganisms, and odours. The tear notch feature may be inserted into the pouch due to the hardness of the aluminium metal foil, and the final layer is polyester. It provides high-temperature resistance, strength and the ability to print graphic (R.Walden,J.Emanuel et al, 2010)

The pouch that contains multiple layer helps to reduce heat exposure, preserving and improving the color, aroma, taste, and shape of food-product and minimizing nutritional loss. There are four common types in the retort pouch product: microwavable pouch, four side seal pouch, zip bag, and center seal pouch.

2.7 Benefits of the pouch

The retort pouch has the several advantages that is the canning and frozen food packaging for food producers, distributors, manufacturers, and customers. Because of the pouch's thinner profile and larger surface place per unit volume, it takes less time to reaching to sterilization temperature between the cans or pans. Furthermore, unlike containers or jars, the liquid at the top is not overcooked, and the food consistency is maintained. There is less nutrient loss, and the color is preserved, the texture is firmer, and the flavor is fresher. The pouch is ideal for things that need a lot of color and texture, including delicate sauces, fish, and entrees. In addition, items for example vegetables can packaged in retorting pouches with less brine for better heating transfer methods. The pouch material must also be commercially safe, need no refrigeration or cooling, and be self-stable at room temperature.

The next advantages of retort pouch are a pouch of food will be eating without being cooked, or it will be heated easily by submerging it in hot water for a few minutes. In addition, frozen food needs only a half-hour of heating. As a result, heating a retort pouch requires less energy. Food in a pouch may also can heating in the microwave oven by separating from the pouch before cooking. Therefore, the pouch can have opened easily and safely by ripping it over the top at a notching at the side sealing or cutting it with the scissors. There's no need for a can opener, and there's no risk of cracked glass or can lids. Handling a pouch right after it has been removed from the boiling water is not a concern.

2.8 Shelf life

The shelf life is defined as the time limit indicated on the best-before label and for how long it can be kept before being thrown. The shelf life, on either perspective, is the length of time before the food is unsafe for consumption. However, the shelf life may refer to the quantity in time a food product can storing and display and is of acceptable quality or performing a specifics function. As a result, the shelf life of a food product usually says little or nothing about safety. If a product reaches the end of its shelf life, it is no longer safe for human consumption because it is no longer passes a set of quality requirements. Pasteurized milk, can remain fresh for days after the expiry date if stored properly, without bacterial contamination (N.W.G.Young & G.R.O'Sullivan.et al, 2011).

CHAPTER 3

METHODOLOGY

3.1 Sample preparation

The total weight of *Macrobrachium rosenbergii* is 2kg and was supplied by Aqua Enterprise and delivered on ice with the specified ratio (ice to prawn ratio of 1:1) to be kept at the animal's laboratory at Universiti Malaysia Kelantan. After being washed with chilled potable water, the *M. rosenbergii* was mixed with the different levels of paste seafood from the Aqua Enterprise. The portion of seafood paste and *M. rosenbergii* was based on the following three treatments: 25%, 50%, and 100% of giant freshwater prawn and paste seafood in the pouch processing process.

3.1.1 Experimental sample

Prepared the sample raw material is *Macrobrachium rosenbergii* and paste to retort and non- retort. The sample of retort is the *Macrobrachium rosenbergii* will mixed with the paste medium value. The table 3.3.1 show the preparation the raw material and retort.

The table 3.1.1. The preparation the raw material of Non-retort

TREATMENT	EXPERIMENTAL COMPOSITION
Raw material/ Non-retort	
U 1	100g of *Macrobrachium rosenbergii*
P 1	100g of paste
U + P 1	100 g *of Macrobrachium rosenbergii +* paste

The table 3.1.2 The preparation the retort

TREATMENT	EXPERIMENTAL COMPOSITION
Retort	
T 1	25% of paste seafood is mixed with *Macrobrachium rosenbergii*
T 2	50% of paste seafood is mixed with *Macrobrachium rosenbergii*
T 3	100% of paste seafood is mixed with *Macrobrachium rosenbergii*

3.2 Retort Preparation

3.2.1 Preparation of Retort Pouch

The giant freshwater prawn and paste seafood were put in the stand –up pouch and the pouch stand upright on any flat surface according to the bag's structure at the bottom. There are convenient tear notches near the top of the bag easily to access the bag's press-to-close zipper opening (B.2021). The stand- up pouch was purchased from Hasratmurni Shop, Melaka, Malaysia.

3.2.2 Retort Pouch Filling and Sealing

Around 500 g peeling, deveining, and flashing-fried giant freshwater prawn parts is packing in retort pouches. Each pouch was filled mix a different level of paste, resulting in a packing weight of approximately 400±10 g. To prevent contaminations of the sealing the area in the pouches. The tips of thermocouple were inserting in the retort pouch and it will quickly be injecting with the steam (for about 10 seconds) to extract any remaining air, and then will be sealed tightly. Thermal processing was applied to the sealed pouch in order to optimise the F0 value at processed temperature.

3.3 Sensory Evaluation test

The prawn in the paste medium pouches that were thermally processed was selecting randomly (three retorting pouch for each different levels) and be put in the boiling water for 5 min to be heated. The 20 respondent was taste the sample of prawn mix with seafood paste and was evaluated the different sensory characteristics of the prawn mix with seafood paste sample.

Discriminative sensory assessment, informative sensory evaluation, and user sensory evaluation are the three basic sensory techniques (Miller, 2017). Therefore, the boundary of acceptability was set at a sensory score of 6. The respondents will be asked to rate colour, flavours, chewiness, succulence, hardness, fibrosity, and overall acceptability on a scale of 1–10 (1 = hate 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).

3.4 Thermal process evaluation

Heat was being applied to the filled and sealed pouch is achieving the necessary F0 values, the pouches were filled and sealed. At a 60-second interval, the precisions Thermometer and F0 values integrator were using the monitor core temperature, retorting temperature, F0 value, and cook value (CV). Copper/cupronickel thermocouples with stainless steel electrodes with a length of 50 mm and a diameter of 1.2 mm were used in experiments. For thermal process-sing tests, packaging glands made of 50 mm stainless steel tubes is using. The F0 constants was programmed at T=121.1°C, Z= 10°C, and the CV constants at T= 100°C, and the Z value for calculating the C value was 33°C.

3.5 Instrumental analysis of texture

The Brookfield CT3 Texture Analysis is using to determine the to evaluate texture analysis. Cooking giant freshwater prawn pieces from the pouch was cutting into equal-sized blocks for studying the TPA (Textural Profile Analysis). Eight samples from three pouches was using for analysis. The texture measurement was composing the two consecutive 40% compressions of the sample at a crosshead speed of 12 mm/min. Force by time data from each test was using to calculating the mean values for the TPA parameters. The values for hardness 1 and 2 are the resistance at maximum compression during the 1st and 2nd compressions. The cohesiveness the extent to which the sample could be deformed before rupture is the ratio of the positive force area during the 2nd compression to that during the 1st compression (Area 2/Area 1). Springiness measures the ability of the sample to recover its original form after the deforming force is removed, and is the ratio of the time duration of force input during the 2nd compression to that during the 1st compression (length 2/length 1). Chewiness indicates the work needed to chew a solid sample to a steady state of swallowing (hardness 1 × cohesiveness × springiness in kg), whereas gumminess is the product of hardness and cohesiveness.

3.6 Instrumental Analysis of Colour

The colorimetric index of prawn will be calculated using a Chromameter Meter. Prawn sample will be packed, and colorimeters will be taken in the same plane and fillet grain location as the fillet sample, with the orientation or surface grain of the fillet in the same position to ensure accuracy of the examination. Triplicates of each procedure will be used to ensure accuracy.

3.7 Proximate Analysis

The proximate analysis will perform to determine the amount of chemical composition inside the prawn in the paste medium. These experiments determine the amount of crude protein, crude fibre, ash, moisture content, and crude fat. These experiments are tested on 2 groups that is raw material and retort of prawn in the paste from a different treatment.

3.7.1 Crude Protein

Crude protein was determined using Kjeldahl method. About 1 g of sample was weighed and poured into test tube. Each sample was duplicated to get an accurate result. One tablet of Kjeltabs tablet ($CuSO_4$ and K_2SO_4) was added (increase the boiling point and speed up the rate of reaction) and followed by 12 mL of H_2SO_4 into each digestion tube. Digestion process conducted at 400 °C for 1 hour 30 minutes. The digestion tube with sample cooled for 20 minutes after the digestion process.

50 mL of 40 % NaOH added for distillation process. A total of 80 mL of distilled water was inserted into digestion tube before adding 40 % NaOH. A total of 30 mL of 4 % H_3BO_3 with indicators (methyl red and bromocresol green) used for distillation process in 3 minutes.

After distillation, 0.1 N HCl was using for titration until the colour changes. The volume of HCl used during titration, V recorded. The step was repeated with the replacement on treated the sample U1, U2, P1, P2, U+P1 and U+P2. The formula was given as below:

$$\% \text{ Nitrogen Content} = \frac{(V_S - V_B) \times N \times 14.01}{W \times 10} \times 100\%$$

Where,

V_S = Acid used to titrate sample, mL

V_B = Acid used to titrate a reagent blank, Ml

N = Normality of titrant (0.1)

14.01 = Atomic weight in atomic

W = Weight in gram, of sample standard

10 = Factor to convert mg/gram to percent

% Crude Protein= % Nitrogen Content × 6.25

3.7.2 Crude Fat

FOSS analytical ST 255 Soxtec™ was used from extraction. Aluminium cup was preheated for 30 minutes at 105 °C. W1 was recorded after aluminium cup cooled in a desiccator for 20 minutes. Next, 1 g sample of retort and non-retort was weighed and recorded as W3. The 1 g sample of retort and non-retort poured into filter paper and inserted into thimble while 80 mL of petroleum ether poured into aluminium cup. Extraction was processed for about 1 hour. After extraction, aluminium cup with extraction and extracted the of retort and non-retort put into oven at 105 °C for 30 minutes to remove moisture and petroleum ether. Next, aluminium cup with extracted cooled for 20 minutes in a desiccator. W2 was obtained and recorded after aluminium cup was weighed. Extracted the of retort and non-retort was kept in a small plastics bag for determination on crude fibre. The step was repeated with replacement of treated the sample U1, U2, P1, P2, U+P1 and U+P2. The formula for calculation crude fat content was given below:

$$\%\ \text{Crude Fat} = \frac{W2 - W1}{W3} \times 100\%$$

Where,

W1 = weight of empty aluminium cup, g

W2 = weight of aluminium cup with extraction, g

W3 = weight of sample in g

3.7.3 Crude Fibre

W3 was obtained after weighed the sample and poured into fibre crucible. Next, 1 g of Celite 545 was weighed and inserted into fibre crucible. The sample went through the process by using Fibertec™ 8000 machines for around 2 hours with 1.25 % H_2SO_4 and 1.25 % NaOH. Next, the sample was taken out and placed into oven at 130 °C for 2 hours. After 2 hours, the sample with fibre crucible was taken out and cooled in desiccator for 20 minutes. W1 obtained and recorded. Next, the sample with fibre crucible was placed into furnace at 525 °C for 3 hours. After 3 hours, ashing process was stopped and the temperature was decreased. Next, the sample with fibre crucible was took out and cooled for 20 minutes in desiccator. W2 weighed and recorded. The step was repeated with the replacement on treated the sample U1, U2, P1, P2, U+P1 and U+P2. Formula for calculation % of crude fibre was given below:

$$\% \text{ Crude Fibre} = \frac{W1 - W2}{W3} \times 100\%$$

Where,

W1 = weight of sample with cup after oven, g

W2 = weight of sample with cup after furnace, g

W3 = weight of sample in g

3.7.4 Ash

The crucible with lid was preheated at 105 °C for 30 minutes to remove moisture. Next, the crucible with lid cooled for 20 minutes in desiccator. After cooling, W1 was obtained after weighed crucible with lid. Next, W2 was obtained by weighted 1 sample and the crucible with lid. The sample with crucible was inserted into furnace at 550 °C for 5 hours. After 5 hours, ash with crucible and lid was cooled at desiccator for 20 minutes. W3 obtained and recorded after weighing. Steps were repeated by replacing with treated the sample U1, U2, P1, P2, U+P1 and U+P2. The formula was given below for calculating percentage of ash content:

$$\% \text{ Ash Content} = \frac{W3 - W1}{W2 - W1} \times 100\ \%$$

Where,

W1 = weight of empty crucible with lid, g

W2 = weight of crucible with lid and sample before ashing, g

W3 = weight of crucible with lid and sample after ashing, g

3.7.5 Moisture

First, the retort and non-retort sample was weighed in 1 g and recorded as W3. W1 was obtained and recorded after weighing aluminium foil with the retort and non-retort. Next, the retort and non-retort was placed into oven at 105 °C for 24 hours and W2 obtained and recorded after 24 hours. The step was repeated with the replacement on treated the sample U1, U2, P1, P2, U+P1 and U+P2. The formula on calculating percentage of moisture content was given below:

$$\% \text{ Moisture Content} = \frac{W1 - W2}{W3} \times 100$$

Where,

W1 = weight of sample with aluminium foil before drying, g

W2 = weight of sample with aluminium foil after drying, g

W3 = weight of sample in g

.

3.8 Stability test

Prepared the sample of *Macrobrachium rosenbergii* mixed with paste seafood in the difference treatments, that is, Treatment 1 (25%), Treatment 2 (50%), and Treatment 3 (100%). Next, the sample will be labelled with T1, T2 and T3. To properly mix the 14.0 g of nutrient agar, add 1000 ml of distilled water. Heat it to boiling to dissolve the medium completely. Sterilize by autoclaving for 2 hours. Allow to cool to 45–50°C.

Next, label the agar plate for T 1 (25%), T 2 (50%) and T 3 (100%). In the Bunsen burner, sanitize the inoculating loop by putting it in the flame until it is red hot. Allow for it to cool. Using near parallel streaks, disseminate an isolated colony from the agar plate culture throughout the first quadrant (about 1/4 of the plate) or put your loop into the tube/culture bottle and extract some inoculum. You don't need a large quantity. Immediately, using a back and forth motion, streak the inoculating loop across a quarter of the plate. Allow the loop to cool before flaming it again. Extend the streaks into the second quarter of the plate, returning to the edge of area 1 where you recently streaked. Allow the loop to cool to flaming it again. Extend the streaks into the second quarter of the plate and return to the edge of area 1 where you recently streaked. Allow the loop to cool before flaming it again. Extend the streaks into the third quarter of the plate, returning to the spot where you recently streaked. Allow the loop to cool before flaming it again. Extend the streaks toward the middle fourth of the plate, returning to the region where you just streaked. Smoulder your loop one more (Aryal, S et al, 2021).

3.9 Collection data and statistical Analysis

All the collected data were analysed using the one-way ANOVA available from Statistical Package for the Social Science (SPSS version 28) to find the significant between treatment group and level of significance 5% ($P<0.05$). Data were presented as mean ± SEM.

CHAPTER 4

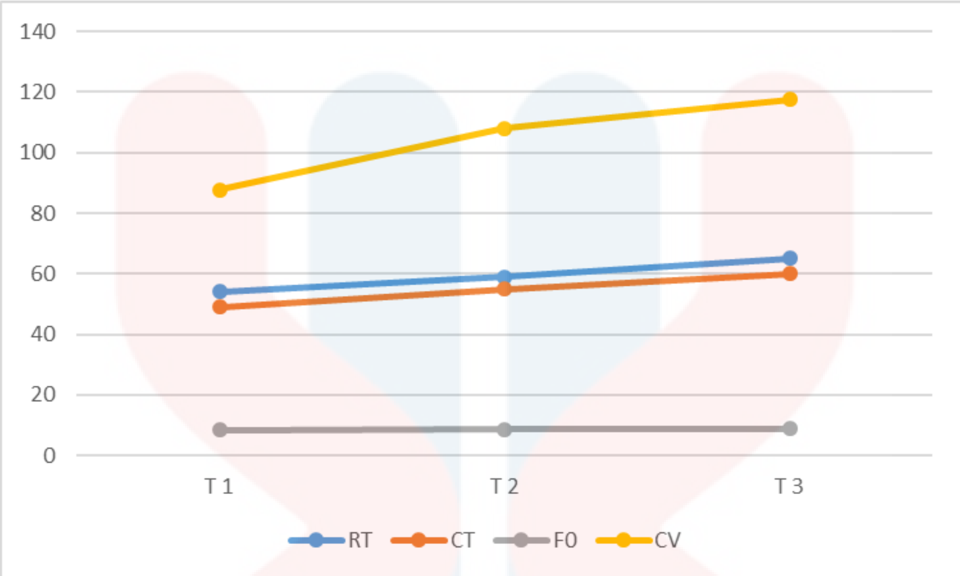
RESULT AND DISCUSSION

4.1 Biochemical and microbiological quality of fresh giant freshwater prawn

Proximate analysis the giant freshwater prawn *Macrobrachium rosenbergii* revealed the moisture, protein, fat, fibre and ash contents for non-retort is U 1 is 13.0 5± 0.22, 10.22 ± 0.12, 7.71 ±2.63,8.15 ± 1.63, 31.21 ± 0.11, for P1 is 20.87 ± 4.02, 10.89 ± 0.75, 8.40 ± 1.32, 6.08 ±1.77, 22.06±0.23 and U+P1 is16.00 ± 0.18, 9.71 ± 0.43, 10.62 ± 1.30, 1.73 ± 4.14, 58.65 ± 0.04. Studies of the biochemical compositions the giant freshwater prawn on non-retort indicated a medium moisture content. The proximate composition giant freshwater prawn in retort is the crude protein, fat, fibre, ash and moisture is T1 19.83 ± 0.14, 10.51 ± 0.44, 11.49 ± 0.57, 11.67 ± 0.33, 25.50±0.34, for T2 20.73 ± 0.03, 9.42 ± 0.44, 10.77 ± 0.27, 13.90 ± 0.06, 25.00±0.06 and T3 23.26 ± 0.87, 10.22 ± 0.27, 10.21 ± 0.26, 15.62 ± 0.24, 25.12 ±0.06. The higher protein content of the giant freshwater prawn because during the harvesting time on the pre-spawning feeding season (March). The fresh prawn meat is pH for T1 5.8 ± 0.11, T2 5.5 ± 0.26 and T3 5.3 ± 0.20

4.2 Thermal processing on the *Macrobrachium rosenbergii*

The *Macrobrachium rosenbergii* was prepared in a paste medium, and the final result was processing at 116.0°C. The paste on the retort pouch is divided into three different treatment F0 values at this treatment temperature (T 1, T 2, T 3). Heating penetration the characteristics of thermally processing in giant freshwater prawn in paste medium is F0 retort pouch that is (T 1, T 2, T 3.) The total process times for giant freshwater prawn in paste medium to reach the F0 values of (T 1, T 2, T 3) were 54, 59, and 65 min, respectively. The processing times are sufficient enough just to develop commercially sterile products. The F0 value increasing, and total processing time is increasing proportionally, as observed in results. The CV represented the product's extent of cooking. The increase on F0 values result in a proportionate increase in the value. When the samples treated to F0 values of T1, T2 and T3, the CV to the giant freshwater prawn in seafood paste medium is 87.60, 107.96, and 117.60 min, respectively.



Next, to destruction of microbes, nutrients are deteriorated, textural changes (usually soften), or enzymes were inactivated (Holdsworth, D & Simpson, R et al. 2007). The impact the thermal processing in food need minimal at any given lethality level, according the CV (Ramaswamy & H.S, et al 1999). Several studies on retort pouching of fishery products is reporting. The recommended F0 value for fish products is between 5 - 20. (Frott, R. &Lewis & A.S et al 1994). For fish curry products, the F0 value is 8.43 was report as the satisfactory (Gopal, T.K.S.; Vijayan, P.K.et al, 2001). The F0 value of 8.79 is sufficient to obtaining the commercially sterile product (Mallick et al, 2006). For Tilapia fish curry, the F0 value of 6.94 with the CV is 107.24 min and the processing time was 50.24 at 116°C is founding the satisfactory (Dhanapal, K.; Reddy, G.V.S. 2010).

4.3 Data analysis of the raw material that is giant freshwater prawn and paste seafood

4.3.1 Proximate composition in raw material

The biochemical composition of treated raw material that is U 1, P1 and U+P 1 is reported in Table 4.3.1. Biochemical compositions (crude protein, crude fat, crude fibre, ash and moisture) shown significantly different ($P < 0.05$) in treated of raw material.

Table 4.3.1: Mean score for Biochemical compositions of raw material with crude protein, crude fat, crude fibre, ash and moisture

Parameter	Sample/ Treatment		
	U 1	P 1	U + P 1
Crude protein %	13.05 ± 0.22	20.87 ± 4.02	16.00 ± 0.18
Crude fat %	10.22 ± 0.12	10.89 ± .075	9.71 ± 0.43
Crude fiber %	7.71 ± 2.63	8.40 ± 1.32	10.62 ± 1.30
Ash %	8.15 ± 1.63	6.08 ± 1.77	1.73 ± 4.14
Moisture %	31.21 ± 0.11	22.06 ± 0.23	58.65 ± 0.04

Mean within column with different letter(s) indicate significance difference between treatments by Tukey's HSD test at $P \leq 0.05$. Column represent the mean values ± standard error

In the table 4.3.1, show the mean score for Biochemical compositions of raw material with crude protein, crude fat, crude fibre, ash and moisture in the treated raw material of U 1, P 1 and U+P 1.

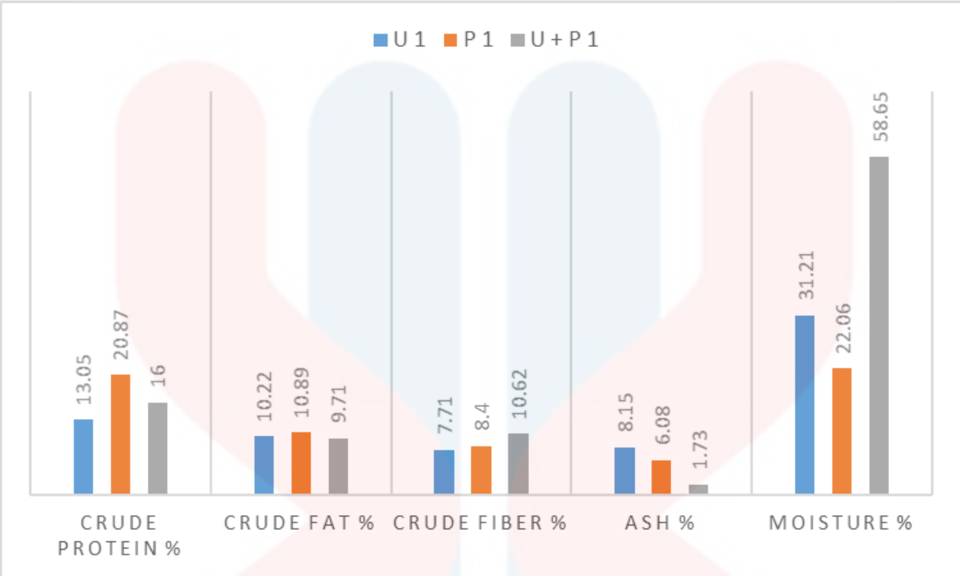


Figure 4.3.1: Percentage of proximate composition in the raw material

Mean percentage of crude protein of raw material of P1 (20.87 ± 4.02) was higher compared the U+P 1 (16.00 ± 0.18) and the lower was U 1 (13.05 ± 0.22). The crude protein content amino acids are composed of proteins. Proteins are important for the regular development,function of bodily tissues and meal the requirement to cover the human requirement. (Thangadurai D et al, 2005). According to Gomez et al. (1988) and Habashy (2009), protein composition is varying by 90% depending on the diet.

Mean percentage of crude fat of raw material of P1 (10.89 ± .075) was higher compared the U 1 (10.22 ± 0.12) and the lower was U+P 1 (9.71 ± 0.43). The lipids is a good sources the energy producers to the bodies the metabolic pathways or metabolic. Lipids also operate as a carrier molecule for nonfat nutrients like A, D, E, and K.Ricardo et al. (2003) and New (1986).

Mean percentage of crude fibre of raw material of U+P 1 (10.62 ± 1.30) was higher compared the P 1 (8.40 ± 1.32) and the lower was U 1 (8.40 ± 1.32). The carbohydrates are the most importance nutrients that it bodies because source of energy from the food (Yvette Brazier et al, 2020).

Mean percentage of ash of raw material of U1 (8.15 ± 1.63) was higher compared the P 1 (6.08 ± 1.77) and the lower was U+P 1(1.73 ± 4.14). Mean percentage of moisture of raw material of U+P 1 (58.65 ± 0.04) was higher compared the U 1 (31.21 ± 0.11) and the lower was P 1 (22.06 ± 0.23). The findings more or less similar is reported that the crude protein, crude fiber, crude fat, ash, and moisture contents in both cultured and frozen prawns was observation on 74.85 ± 0.65, 60.8 ± 0.12, 5.61 ± 0.37, 8.21 ± 0.14, 9.15 ± 0.61, 7.89 ± 0.005, 10.14 ± 0.55, 23.09 ± 0.39, 77.1 ± 1.69, 74.9 ± 0.98. (Ferdose & Hossain et al, 2011).

4.3.2 Physical properties in raw material

The physical properties of treated raw material were reported in Table 4.3.2. The physical properties are hardness, cohesiveness, springiness, gumminess and chewiness was shown statistically significant ($P < 0.05$).

Table 4.3.2. Physical properties (hardness, cohesiveness, springiness, gumminess and chewiness) in raw material

Parameter (TPA)	**Sample/ Treatment**		
	U 1	P 1	U + P 1
Hardness	6851.667 ± 231.33	5894.677 ± 1693.21	7922.667 ± 708.27
Cohesiveness	1.053 ± 0.33	0.693 ± .0.10	0.980 ± 0.07
Springiness	1.243 ± 0.24	0.82 ± 0.30	0.59 ± 0.80
Gumminess	7038.33 ± 1982.83	4031.33 ± 987.19	7740.33 ± 208.71
Chewiness	757.53 ± 29.16	234.40 ± 46.65	414.00 ± 75.30

Mean within column with different letter(s) indicate significance difference between treatments by Tukey's HSD test at $P \leq 0.05$. Column represent the mean values ± standard error.

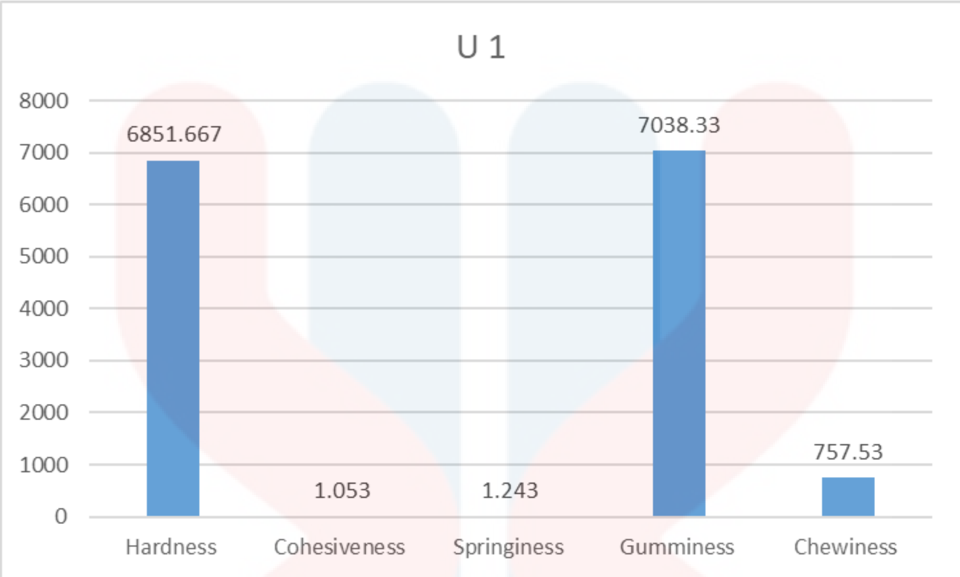


Figure 4.3.1: The percentage of TPA in treated U 1

The mean percentage of hardness (6851.667 ± 231.33), cohesiveness (1.053 ± 0.33), springiness (1.243 ± 0.24), gumminess (7038.33 ± 1982.83) and chewiness (757.53 ± 29.16).

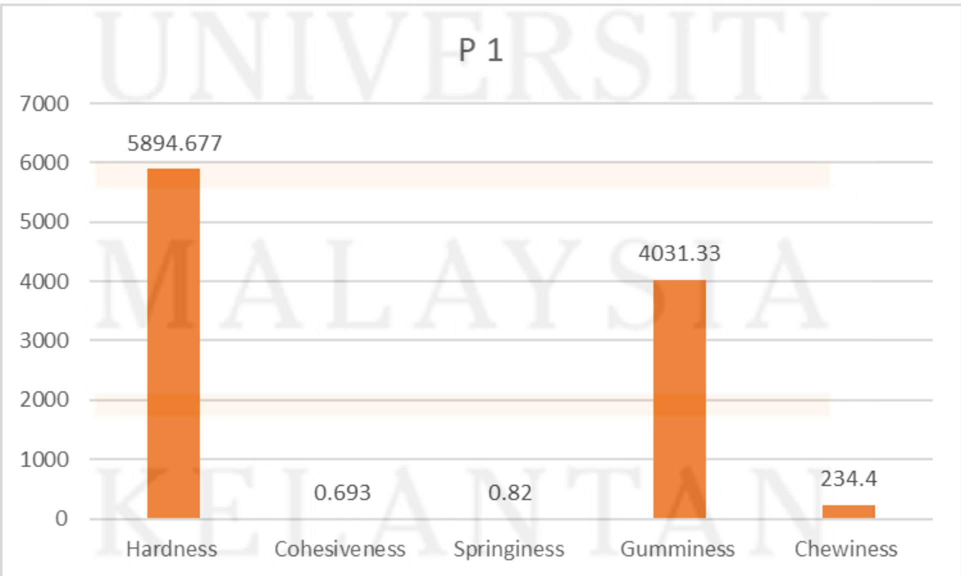


Figure 4.3.2: The percentage of TPA in treated P 1

The mean percentage of hardness (5894.677 ± 1693.21), cohesiveness (0.693 ± .0.10), springiness (0.82 ± 0.30), gumminess (4031.33 ± 987.19) and chewiness (234.40 ± 46.65).

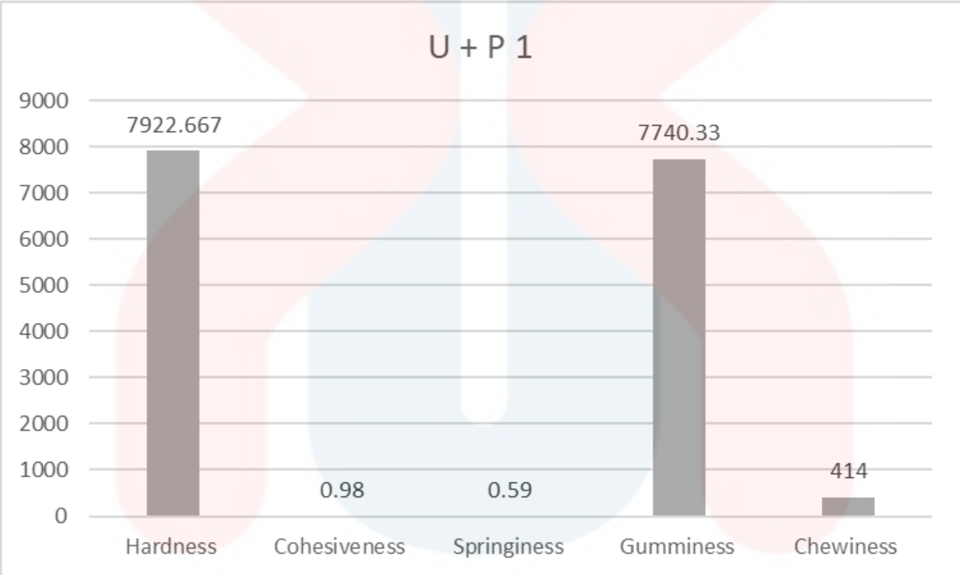


Figure 4.3.3: The percentage of TPA in treated U + P 1

The mean percentage of hardness (7922.667 ± 708.27), cohesiveness (0.980 ± 0.07), springiness (0.59 ± 0.80), gumminess (7740.33 ± 208.71) and chewiness (414.00 ± 75.30).

4.3.3 Color characteristics of raw material

The colour characteristics is (*L** (lightness value), *a** (red/green value), and *b** (yellow/blue value) scale) was reported statistically significant (P < 0.05) in all treated of raw material. From Table 4.3, there is no difference on the colour characteristics in U 1 (*L**44.48 ± 0.93, *a** 1.10 ± 0.09, *b**5.32 ± 0.25), P 1 (*L**29.75 ± 1.64, *a**3.85 ± 0.17, *b**11.31 ± 0.19) and U+P 1 (*L**40.11 ± 1.31, *a**3.67 ± 0.43, *b**14.29 ± 0.70)

Table 4.3.3: Colour Characteristics of raw material with CIE *L* a* b** scale

Parameter (Calorimetry)	Sample/ Treatment		
	U 1	P 1	U + P 1
L* scale (lightness)	44.48 ± 0.93	29.75 ± 1.64	40.11 ± 1.31
a* scale (redness)	1.10 ± 0.09	3.85 ± 0.17	3.67 ± 0.43
b* scale (yellowness)	5.32 ± 0.25	11.31 ± 0.19	14.29 ± 0.70

Mean within column with different letter(s) indicate significance difference between treatments by Tukey's HSD test at P ≤ 0.05. Column represent the mean values ± standard error

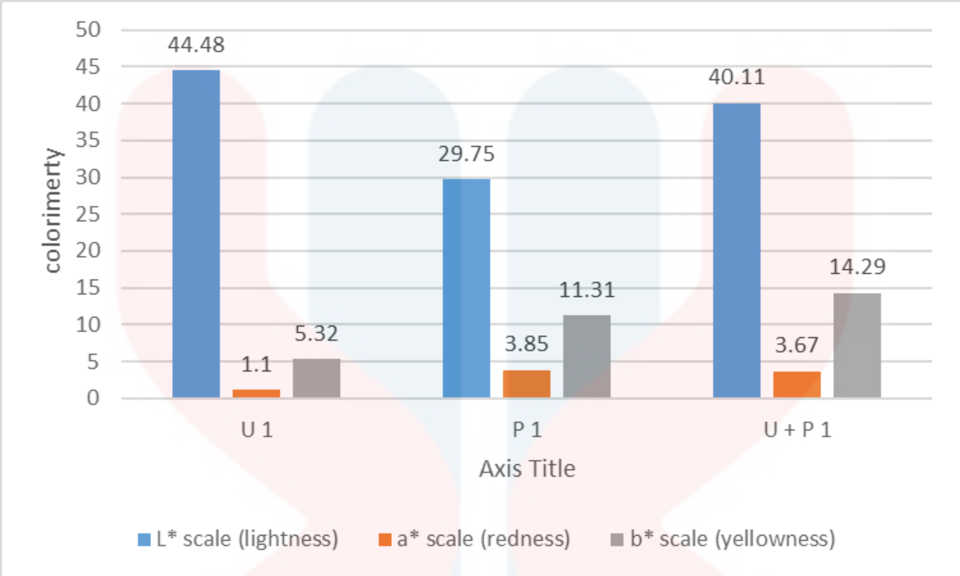


Figure 4.3.3: Colour Characteristics of raw material with CIE *L* a* b** scale

The mean percentage of color characteristics raw material is U 1 (*L**44.48 ± 0.93, *a** 1.10 ± 0.09, *b**5.32 ± 0.25), P 1 (*L**29.75 ± 1.64, *a**3.85 ± 0.17, *b**11.31 ± 0.19) and U+P 1 (*L**40.11 ± 1.31, *a**3.67 ± 0.43, *b**14.29 ± 0.70).

4.3.4 pH meter of raw material

The pH meter of raw material was U 1 (5.1 ± 0.11), P 1 (5.3 ± 0.29) and U+P 1 (4.1 ± 0.15)

Table 4.3.4: pH meter of raw material

Parameter (pH meter)	Sample/ Treatment		
	U 1	P 1	U + P 1
pH meter	5.1 ± 0.11	5.3 ± 0.29	4.1 ± 0.15

Mean within column with different letter(s) indicate significance difference between treatments by Tukey's HSD test at $P \leq 0.05$. Column represent the mean values ± standard error

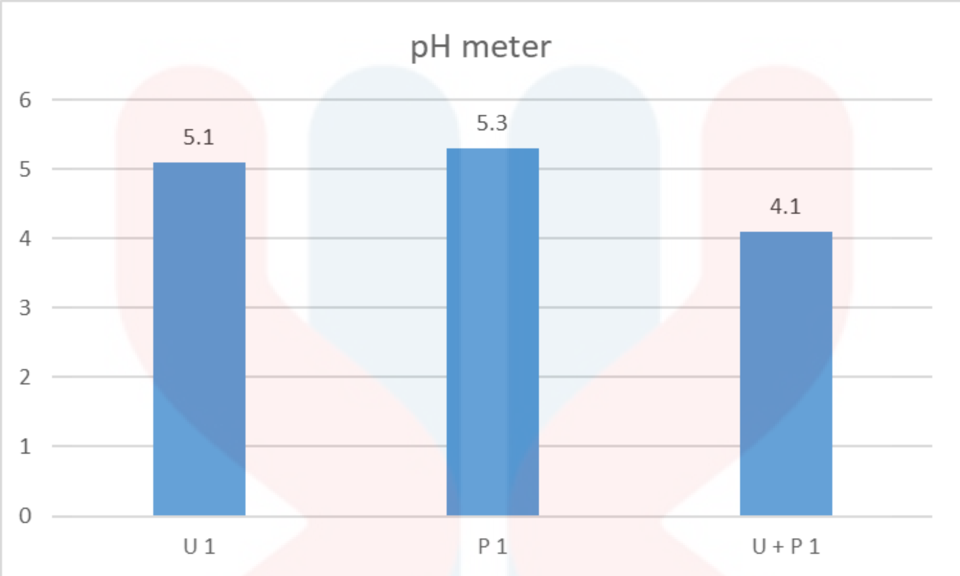


Figure 4.3.4: pH meter of raw material

The mean percentage of pH meter raw material is U1 (5.1 ± 0.11), P1 (5.3 ± .0.29) and U + P1 (4.1 ± 0.15). The pH profile of *M.rosenbergii* is to explaining of inability the parameter to evaluating quality of *M.rosenbergii*. The changes in pH meter can be combined with the indicator for example the volatile acids and total volatile bases. The total volatile acids in the giant freshwater prawn is increasing steady in the small amount during the storage time

4.4 Data analysis of retort processing

4.4.1 Proximate composition of retort.

The biochemical composition of treating in retort that is T 1, T2 and T 3 was reported in Table 4.4.1. Biochemical compositions (crude protein, crude fat, crude fibre, ash and moisture) shown significantly different ($P < 0.05$) in treated of raw material.

Table 4.4.1: Mean score for Biochemical compositions of raw material with crude protein, crude fat, crude fibre, ash and moisture

Parameter	Sample/ Treatment		
	T 1	T 2	T 3
Crude protein %	19.83 ± 0.14	20.73 ± 0.03	23.26 ± 0.87
Crude fat %	10.51 ± 0.44	9.42 ± 0.44	10.22 ± 0.27
Crude fiber %	11.49 ± 0.57	10.77 ± 0.27	10.21 ± 0.26
Ash %	11.67 ± 0.33	13.90 ± 0.06	15.62 ± 0.24
Moisture %	25.50 ± 0.34	25.00 ± 0.06	25.12 ± 0.15

Mean within column with different letter(s) indicate significance difference between treatments by Tukey's HSD test at $P \leq 0.05$. Column represent the mean values ± standard error

In the table 4.4.1, show mean score for Biochemical compositions of raw material with

crude protein, fat, fibre, ash and moisture in the treated of retort T 1, T 2 and T 3.

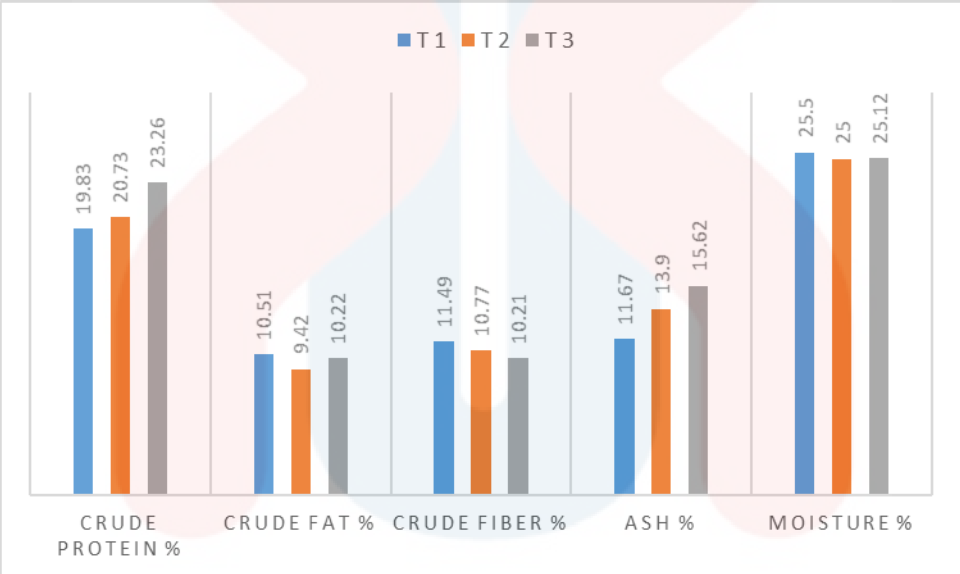


Figure 4.1.1: The percentage proximate composition of retort

Mean percentage of crude protein of retort of T 3 (23.26 ± 0.87) was higher compared the T 2 (20.73 ± 0.03) and the lower was T 1 (10.51 ± 0.44). According to Kong et al. (2008), adding salt to thermally treated salmon fillets decreased cook loss. The salt can solubility of proteins, resulting in increasing protein–protein and protein–water interactions because the meat of giant freshwater prawn increasing during the harvesting time.

Mean percentage of crude fat of retort of T 1 (10.51 ± 0.44) was higher compared the T 3 (10.22 ± 0.27) and the lower was T 2 (9.42 ± 0.44). Pretreatments, retorting conditions, and salt concentration all influence the amount of liquid loss (Almonacid et al., 2012). While adding the salt in thermally treated salmon fillets decreased cooking loss. Kong et al. (2008)

Mean percentage of crude fibre of retort of T 1 (11.49 ± 0.57) was higher compared the T 2 (10.77 ± 0.27) and the lower was T 3 (10.21 ± 0.26). Mean percentage of ash of retort of T 3 (15.62 ± 0.24) was higher compared the T 2 (13.90 ± 0.06) and the lower was T 1 (11.67 ± 0.33). Mean percentage of ash of retort of T 1 (25.50 ± 0.34) was higher compared the T 3 (25.12 ± 0.15) and the lower was T 2 (25.00 ± 0.06).

4.4.2 Physical properties of retort

The physical properties of treated raw material were reported in Table 4.4.2. The physical properties are hardness, cohesiveness, springiness, gumminess and chewiness) were shown statistically significant (P < 0.05).

Table 4.4.2. Physical properties (hardness, cohesiveness, springiness, gumminess and chewiness) in raw material

Parameter (TPA)	**Sample/ Treatment**		
	T 1	T 2	T 3
Hardness	3680.00 ± 26.65	5763.67 ± 29.96	3768.33 ± 6.93
Cohesiveness	2.02 ± 0.05	1.99 ± .0.00	2.05 ± 0.02
Springiness	1.00 ± 0.02	1.48 ± 0.43	1.26 ± 0.11
Gumminess	7091.33 ± 30.68	7044.67 ± 6.64	7046.00 ± 2.08
Chewiness	703.67 ± 18.51	682.87 ± 6.31	790.94 ± 5.08

Mean within column with different letter(s) indicate significance difference between treatments by Tukey's HSD test at P ≤ 0.05. Column represent the mean values ± standard error

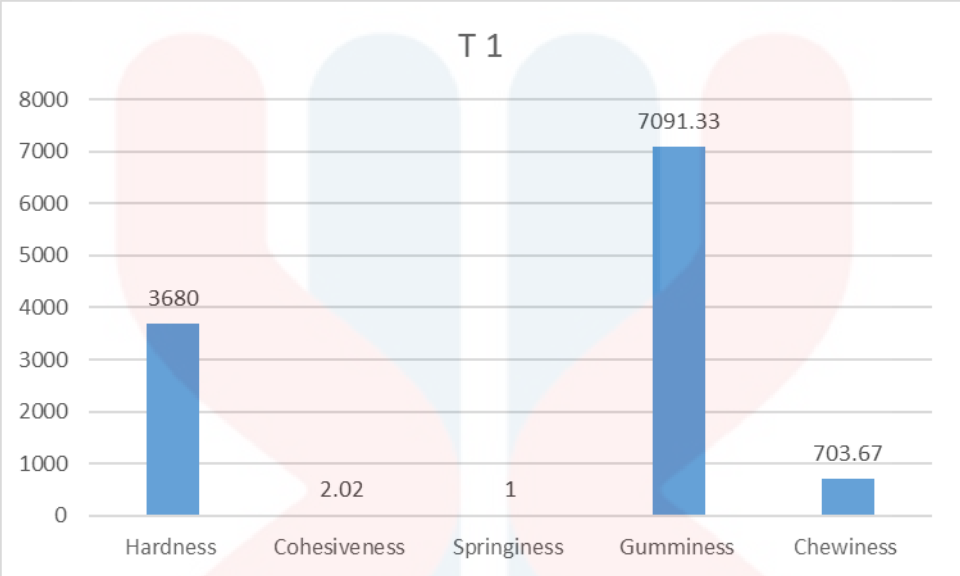


Figure 4.4.1: Percentage TPA of retort T 1

The mean percentage of retort T 1 is hardness (3680.00 ± 26.65), cohesiveness (2.02 ± 0.05), springiness (1.00 ± 0.02), gumminess (7091.33 ± 30.68) and chewiness (703.67 ± 18.51).

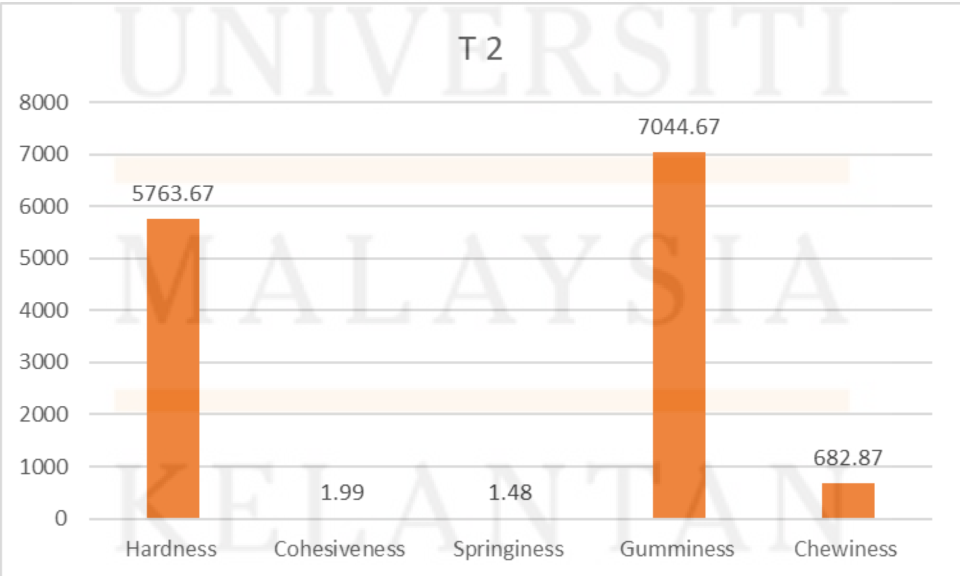


Figure 4.4.2: Percentage TPA of retort T 2

The mean percentage of retort T 2 is hardness (5763.67 ± 29.96), cohesiveness (1.99 ± .0.00), springiness (1.48 ± 0.43), gumminess (7044.67 ± 6.64) and chewiness (682.87 ± 6.31).

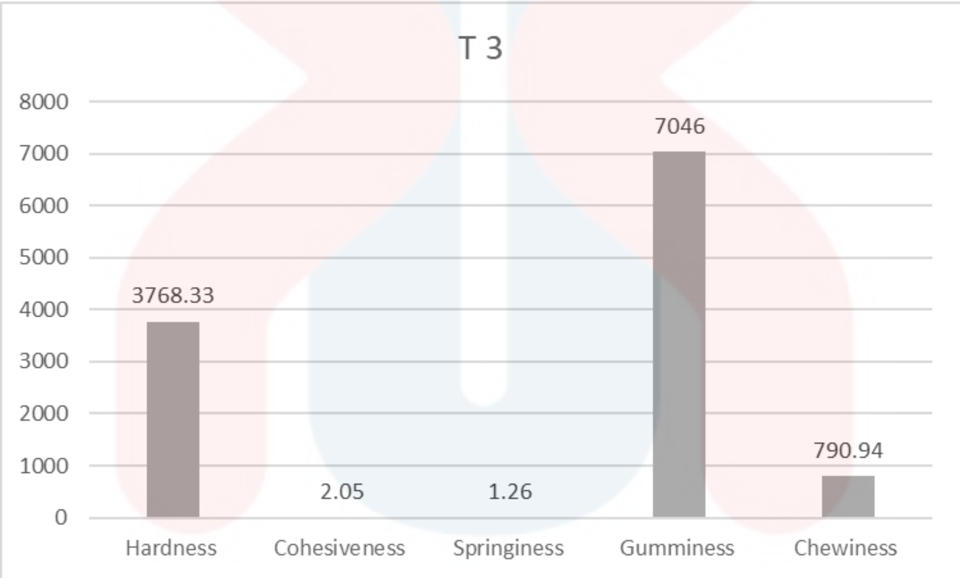


Figure 4.4.3: Percentage TPA of retort T 3

The mean percentage of retort T 3 is hardness (3768.33 ± 6.93), cohesiveness (2.05 ± 0.02), springiness (1.26 ± 0.11), gumminess (7046.00 ± 2.08) and chewiness (790.94 ± 5.08).

4.4.3 Colorimeter of retort

Colour characteristics (*L** (lightness value), *a** (red/green value), and *b** (yellow/blue value) scale) shown statistically significant ($P < 0.05$) in all treated of raw material. From Table 4.3, the colour characteristics in T 1 (*L**49.82 ± 0.05, *a**7.81 ± 0.05, *b**24.95 ± 0.02), T 2 (*L**49.30 ± 0.01, *a**8.49 ± 0.04, *b**23.51 ± 0.06) and T 3 (*L**37.13 ± 0.08, *a**4.16 ± 0.02, *b**15.79 ± 0.04)

Table 4.3.3: Colour Characteristics of raw material with CIE *L** *a** *b** scale

Parameter (Calorimetry)	Sample/ Treatment		
	T 1	T 2	T 3
L* scale (lightness)	49.82 ± 0.05	49.30 ± 0.01	37.13 ± 0.08
a* scale (redness)	7.81 ± 0.05	8.49 ± 0.04	4.16 ± 0.02
b* scale (yellowness)	24.95 ± 0.02	23.51 ± 0.06	15.79 ± 0.04

[ab]Mean with different superscripts in a row is significantly different ($P \leq 0.05$)

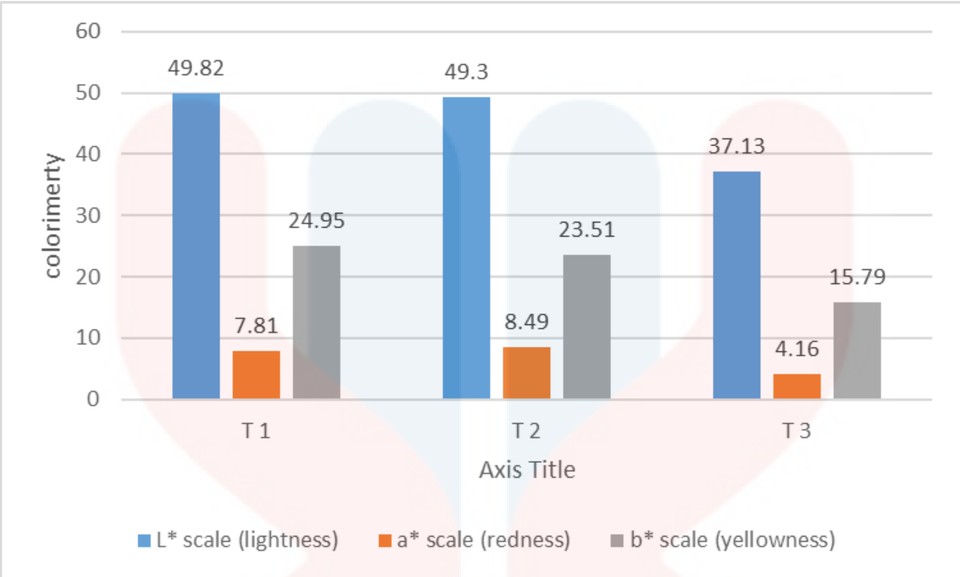


Figure 4.3.3: Colour Characteristics of raw material with CIE *L* a* b** scale

The changes in colour characteristics throughout the thermal processing of giant freshwater prawns in seafood paste to various F0 values. For prawns thermally treated the F0 values of T1, T2 and T3, the L* value (lightness) was 49.82, 59.30, and 37.13, respectively. For shrimps treated to F0 values of T1, T2 and T3 the a* value (green to red) was 7.81, 8.49 and 416 recording. The b* value (blue to yellow) was 24.95, 23.51 and 15.79, the of L* and b* values showed a increasing trend, but a* values showed an decreasing trends and F0 values increasing. This might the due to giant freshwater prawn's colour being affected by extended heat treatment (Hayakawa, K.; Timbers, G.E et al,1977). The release the astaxanthin pigment by the prolonged heating treatment may be responsible for the rise in thered colour (a* value) in the giant freshwater prawn (Okada, S.; Nur Ebrhan, S. A et al, 1994). The development of reds pigment as a resulting of prolonged heating treatment, nonenzymatic browning, or Maillard processes might explain the reduction on the lightness (L* value) and yellow colour (b* value) of the thermally processing giant freshwater prawn as the F0 value rises (Nisha, P.; Singhal, R.S. 2011)

4.4.4 pH meter

The pH meter of retort was T 1 (5.8 ± 0.11), T 2 (5.5 ± 0.26) and T 3 (5.3 ± 0.20)

Table 4.4.4: The pH meter of retort

Parameter (pH meter)	Sample/ Treatment		
	T 1	T 2	T 3
pH meter	5.8 ± 0.11	5.5 ± 0.26	5.3 ± 0.20

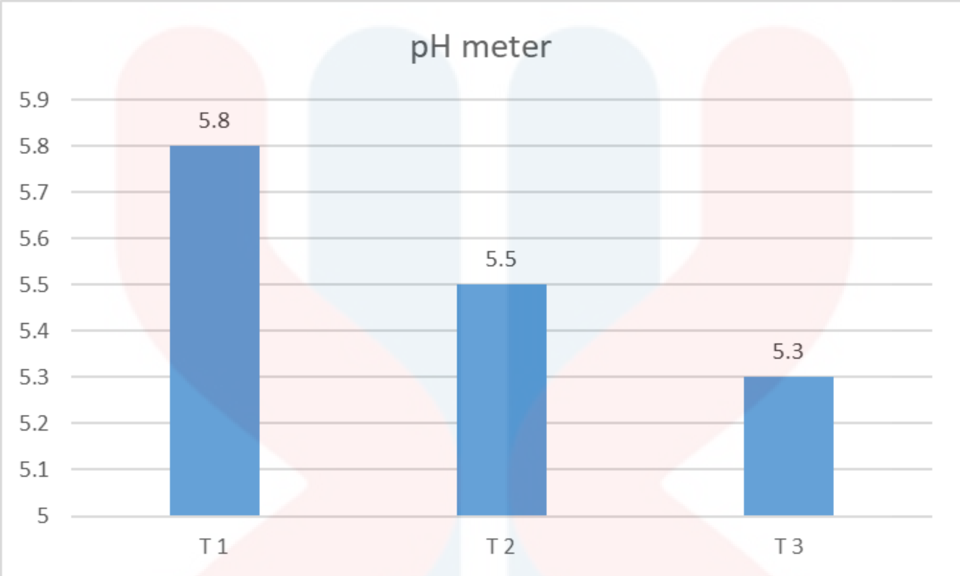


Figure 4.3.5: The pH meter of retort processing

The mean percentage of pH meter retort processing is T1 (5.8 ± 0.11), T2 (5.5 ± .0.26) and T3 (4.1 ± 0.15). The pH profile of *M.rosenbergii* is to explaining of inability the parameter to evaluating quality of *M.rosenbergii*. The changes in pH meter can be combined with the indicator for example the volatile acids and total volatile bases. The total volatile acids in the giant freshwater prawn is increasing steady in the small amount during the storage period.

4.5 Sensory analysis

The *Macrobrachium rosenbergii* in paste medium to difference treatment were analysed by 20 sensory panellists. The table 4.4 show the data of sensory analysis *Macrobrachium rosenbergii* in paste medium.

Table 4.4 show the data of sensory analysis *Macrobrachium rosenbergii* in paste medium.

Sensory test	Treatment		
	T 1	T 2	T3
Colour	8.81 ± 1.17	8.81 ± 0.92	9.52 ± 0.75
Flavour	8.71 ± 1.38	7.86 ± 1.49	9.24 ± 0.94
Chewiness	8.52 ± 8.52	8.19 ± 0.87	9.00 ± 1.09
Succulence	8.00 ± 1.64	7.90 ± 1.48	9.14 ± 1.23
Toughness	7.48 ± 1.72	7.29 ± 1.45	8.29 ± 1.52
Fibrosity	7.90 ± 1.48	7.81 ± 0.98	9.19 ± 0.87
Overall acceptability	8.95 ± 1.16	8.14 ± 1.52	9.57 ± 0.97

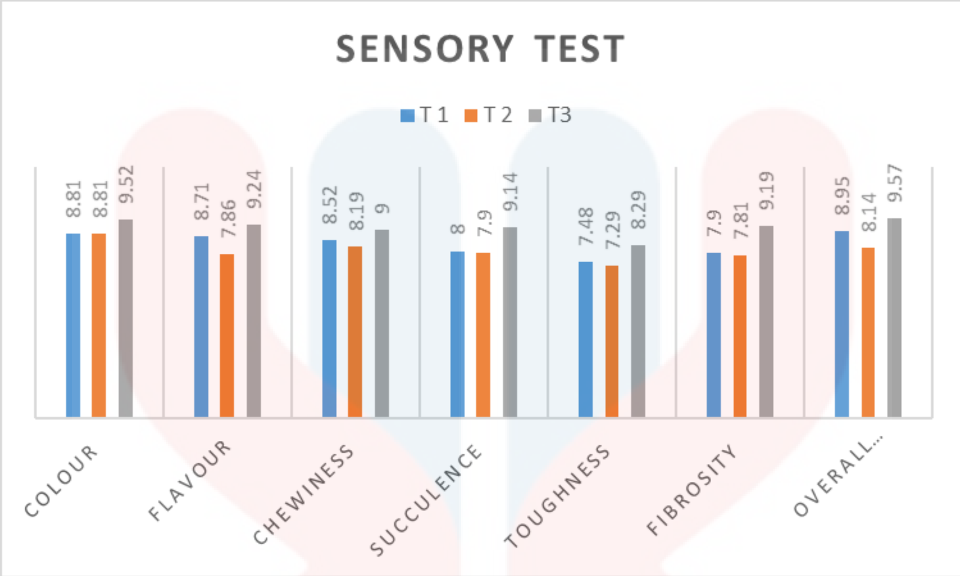


Figure 4.4: The data of sensory analysis *Macrobrachium rosenbergii* with paste seafood

In terms of flavour, panellists gave processed prawn 8.71, 7.86, and 9.24, corresponding to F0 scores T1, T2 and T3, respectively. According to the aforementioned findings, the colour and flavour of the retort pouch-processed prawn increasing at the F0 value is increasing. The might be explaining by the extended cooking, which encourages colours and flavours development in ultimate products. Textural measures such as succulence, toughness, and fibrosity exhibited decreasing trends, however the chewiness parameter did not show any change. Cooking has an impact on the finished product's muscular rigidity and texture. The longer cooking time may be to blame for the reduction in textural qualities. The panellists' highest overall acceptance score for the items treated to F0 value T3 was 9.57 ± 0.0.97(Ma, L.Y.; Deng, J.C et al, 1983).

4.6 Shelf life of *Macrobrachium rosenbergii* in retort processing

The shelf life of *Macrobrachium rosenbergii* is observed in T 1, T 2 and T 3 to know any microorganisms in the product after overnight and the purpose is to see how many bacteria can grow on overnight in food product. The table 4.5 show the count number of bacteria and colonies.

The table 4.6 show the count number of bacteria and colonies.

Treatment	Number of colonies
Treatment 1 (25%)	19 (100)
Treatment 2 (50%)	20 (100)
Treatment 3 (100%)	17 (100)

From the observation T 1, the pouch is in good condition and no leaking. The prawn paste medium is not broken, not greasy and has a little gravy and sour. Next, for T 2, the pouch in good condition and not leaking. The prawn paste medium not crushed, not greasy, has a lot of medium gravy and is very sour. Finally, for T3, the condition of the pouch good condition. The pawn paste medium is not greasy, has a lot of gravy and tasty.

The potential of growth the Listeria monocytogenes reduced the shelfs life of cooking and peeling MAP giant freshwater prawn more than growth of the spoilage bacteria and nonproteolytic Cl. botulinum. Our findings imply that cooked and peeled MAP shrimps should be maintained at 2C and cooler to avoid Listeria monocytogenes from reaching critical concentrations. Furthermore, the maximum claimed shelf life should be limited to 20–21 days at 2C, 8–9 days at 5C, and 4–5 days at 8ºC, equivalent to the period necessary for Listeria. monocytogenes to grows 100-fold with no lag phase. Cooking inactivates Listeria monocytogenes, but the pathogens might still presence in the cooking and peeling product, providing storage temperature and time constraints (Destro et al. 1996; Valdimarsson et al. 1998). Cooking shrimp inactivates Listeria monocytogenes,and the pathogen can spread it in the cooking and peeling product and storage limits as stated previously, temperature and shelf life are significant factors.

CHAPTER 5

CONCLUSION

5.1 Conclusion

Freshwater prawn with paste seafood was cooked and then thermally treated at difference treatment is T 1, T 2 and T 3. The process flow time increase at the T 3 increasing, according the results. The textural characteristics of retort-processed freshwater prawn *M. rosenbergii* such as the hardness, cohesiveness, springiness, gumminess, and chewiness followed the same trend and showed an increase at Treatment 3 because the cohesiveness and chewiness of the meat of the giant freshwater prawn compared to Treatment 1 and Treatment 2. The sensory characteristics of retort-processed freshwater prawn *M. rosenbergii* such as the colour, flavour, chewiness, succulence, toughness and overall acceptability show the increasing at Treatment 3 because the colour, flavour, succulence,toughness,fibrosity and overall acceptability because the giant freshwater prawn with paste seafood is not greasy, has a lot of gravy and tasty.

Malaysian industries to provide better food manufacturing units and marketing infrastructure ensure how they can serve high-quality, safe processed and RTE foods. The retort with the overpressure of viable alternative in shellfish processing for non-refrigerated storage and sale enabling can spread the products in previously emerging markets.

5.2 Recommendation

Creating specific technology to determine the different of freshwater prawn nutrient composition can be achieved on their biochemical composition. The retort recommended due to higher cost and low resource availability and sustainability to reduce the financial support for enterprise to sell their product. The retort processing can't take a long time to cooked and the product durable and easy to eat.

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APPENDIX

Figure A1: Preparation the chemical for proximate analysis

Figure A2: Preparation the raw material

Figure A 3 Preparation the sample

Figure A4: Kjeldahl method used to determination of crude protein, three steps were involved: a) digestion, b) distillation, c) titration

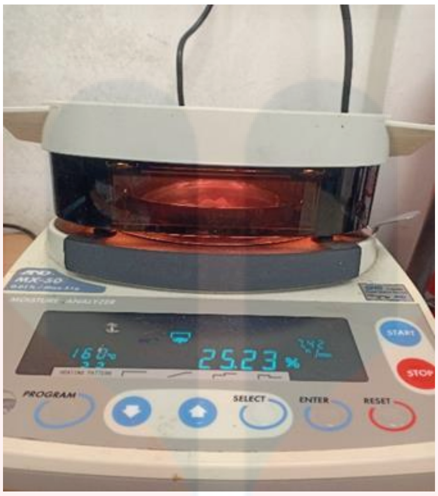

Figure A5: Analyse moisture

Figure A6: FOSS analytical ST 255 Soxtec™ used to extract fat in sample.

Figure A7: FOSS Fibertec™ 8000 machines used for identify crude fibre in sample.

Figure A8: Furnace used for burning sample into ash

Figure A9: Brookfield CT3 Texture Analyser with cylinder probe used to determine the hardness of formulated egg custard

Figure A10: Colorimeter

Figure A11: pH meter

Descriptive of raw material (proximate analysis)

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
PROTEIN	U 1	3	13.0500	.39230	.22650	12.0755	14.0245	12.78	13.50
	P 1	3	20.8733	6.99882	4.04077	3.4873	38.2594	13.05	26.54
	U + P 1	3	16.0000	.31480	.18175	15.2180	16.7820	15.65	16.26
	Total	9	16.6411	4.90063	1.63354	12.8742	20.4081	12.78	26.54
FAT	U 1	3	10.2233	.22502	.12991	9.6644	10.7823	9.97	10.40
	P 1	3	10.8967	1.30577	.75389	7.6530	14.1404	9.39	11.70
	U + P 1	3	9.7167	.75659	.43682	7.8372	11.5961	8.99	10.50
	Total	9	10.2789	.91915	.30638	9.5724	10.9854	8.99	11.70
FIBER	U 1	3	7.7100	4.65178	2.68571	-3.8457	19.2657	2.36	10.80
	P 1	3	8.4033	2.34781	1.35551	2.5710	14.2356	6.24	10.90
	U + P 1	3	10.6233	2.26708	1.30890	4.9916	16.2551	8.07	12.40
	Total	9	8.9122	3.13206	1.04402	6.5047	11.3197	2.36	12.40
ASH	U 1	3	8.1593	1.63748	.94540	4.0916	12.2271	6.27	9.22
	P 1	3	6.0857	1.77083	1.02239	1.6867	10.4847	4.34	7.88
	U + P 1	3	11.7303	4.14162	2.39116	1.4420	22.0187	7.01	14.76
	Total	9	8.6584	3.44338	1.14779	6.0116	11.3053	4.34	14.76
MOISTURE	U 1	3	31.2167	.11015	.06360	30.9430	31.4903	31.11	31.33

		N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
	P 1	3	22.0667	.23459	.13544	21.4839	22.6494	21.88	22.33
	U + P 1	3	58.6567	.04041	.02333	58.5563	58.7571	58.62	58.70
	Total	9	37.3133	16.49107	5.49702	24.6372	49.9895	21.88	58.70

Descriptive PH METER (RAW MATERIAL)

PH

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	Upper Bound	Minimum	Maximum
U 1	3	5.1667	.25166	.14530	4.5415	5.7918	4.90	5.40
P 1	3	5.3333	.51316	.29627	4.0586	6.6081	4.90	5.90
U + P 1	3	4.1000	.26458	.15275	3.4428	4.7572	3.80	4.30
Total	9	4.8667	.65955	.21985	4.3597	5.3736	3.80	5.90

Descriptive Of COLOR ANALYSIS (raw material)

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	Upper Bound	Minimum	Maximum
Lightness (L)	U 1	3	44.4800	1.62530	.93837	40.4425	48.5175	42.64	45.72
	P 1	3	29.7567	2.85561	1.64869	22.6629	36.8504	26.47	31.63
	U + P 1	3	40.1167	2.28572	1.31966	34.4386	45.7947	37.93	42.49
	Total	9	38.1178	6.84823	2.28274	32.8538	43.3818	26.47	45.72
Redness (R	U 1	3	1.1033	.16862	.09735	.6845	1.5222	.91	1.22
	P 1	3	3.8500	.29462	.17010	3.1181	4.5819	3.53	4.11
	U + P 1	3	3.6767	.74969	.43283	1.8143	5.5390	3.19	4.54
	Total	9	2.8767	1.39422	.46474	1.8050	3.9484	.91	4.54
Yellowness (B)	U 1	3	5.3200	.44643	.25775	4.2110	6.4290	4.81	5.64
	P 1	3	11.3167	.33471	.19325	10.4852	12.1481	10.94	11.58
	U + P 1	3	14.2967	1.21969	.70419	11.2668	17.3265	12.89	15.06
	Total	9	10.3111	4.01589	1.33863	7.2242	13.3980	4.81	15.06

Descriptive textural analysis (RAW MATERIAL)

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Hardness	U 1	3	6851.6667	400.68608	231.33622	5856.3073	7847.0261	6389.00	7085.00
	P 1	3	5894.6667	2932.74024	1693.21837	-1390.6640	13179.9973	2552.00	8036.00
	U + P 1	3	7922.6667	1226.76662	708.27404	4875.2094	10970.1239	6573.00	8970.00
	Total	9	6889.6667	1827.17733	609.05911	5485.1738	8294.1595	2552.00	8970.00
Cohesiveness	U 1	3	1.0533	.57744	.33338	-.3811	2.4878	.71	1.72
	P 1	3	.6933	.18610	.10745	.2310	1.1556	.52	.89
	U + P 1	3	.9800	.12288	.07095	.6747	1.2853	.89	1.12
	Total	9	.9089	.35062	.11687	.6394	1.1784	.52	1.72
Springiness	U 1	3	1.2433	.41885	.24182	.2029	2.2838	.76	1.50
	P 1	3	.8233	.53669	.30986	-.5099	2.1565	.38	1.42
	U + P 1	3	.5967	.14572	.08413	.2347	.9586	.48	.76
	Total	9	.8878	.44935	.14978	.5424	1.2332	.38	1.50
Gummininess	U 1	3	7038.3333	3434.36899	1982.83386	-1493.1122	15569.7788	5053.00	11004.00
	P 1	3	4031.3333	1709.86442	987.19068	-216.2054	8278.8720	2259.00	5671.00
	U + P 1	3	7740.3333	361.49873	208.71139	6842.3207	8638.3460	7333.00	8023.00
	Total	9	6270.0000	2573.66349	857.88783	4291.7071	8248.2929	2259.00	11004.00
Chewiness	U 1	3	757.5333	50.52231	29.16907	632.0290	883.0377	725.90	815.80
	P 1	3	234.4000	80.80019	46.65001	33.6812	435.1188	153.50	315.10
	U + P 1	3	414.0000	130.43079	75.30425	89.9920	738.0080	329.30	564.20
	Total	9	468.6444	243.95863	81.31954	281.1212	656.1677	153.50	815.80

Descriptive Of retort (Proximate Analysis)

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
FAT	MIX 1	3	10.5133	.77880	.44964	8.5787	12.4480	9.94	11.40
	MIX 2	3	9.2433	.76226	.44009	7.3498	11.1369	8.64	10.10
	MIX 3	3	10.2267	.36074	.20827	9.3305	11.1228	9.88	10.60
	Total	9	9.9944	.81374	.27125	9.3689	10.6199	8.64	11.40
PROTEIN	MIX 1	3	19.8300	.25239	.14572	19.2030	20.4570	19.60	20.10
	MIX 2	3	20.7300	.05292	.03055	20.5986	20.8614	20.69	20.79
	MIX 3	3	23.2600	1.50692	.87002	19.5166	27.0034	22.38	25.00
	Total	9	21.2733	1.71939	.57313	19.9517	22.5950	19.60	25.00
FIBER	MIX 1	3	11.4900	1.00165	.57830	9.0018	13.9782	10.37	12.30
	MIX 2	3	10.7733	.46801	.27021	9.6107	11.9359	10.45	11.31
	MIX 3	3	10.2133	.04509	.02603	10.1013	10.3253	10.17	10.26
	Total	9	10.8256	.78309	.26103	10.2236	11.4275	10.17	12.30
ASH	MIX 1	3	11.6733	.57457	.33173	10.2460	13.1007	11.02	12.10
	MIX 2	3	13.9033	.10504	.06064	13.6424	14.1643	13.80	14.01
	MIX 3	3	15.6233	.42158	.24340	14.5761	16.6706	15.37	16.11
	Total	9	13.7333	1.75256	.58419	12.3862	15.0805	11.02	16.11
MOISTURE	MIX 1	3	25.5067	.59677	.34454	24.0242	26.9891	24.82	25.90
	MIX 2	3	25.0067	.10504	.06064	24.7457	25.2676	24.90	25.11
	MIX 3	3	25.1200	.26963	.15567	24.4502	25.7898	24.94	25.43
	Total	9	25.2111	.40188	.13396	24.9022	25.5200	24.82	25.90

Descriptive PH METER (RETORT)

pH METER

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
MIX 1	3	5.8000	.20000	.11547	5.3032	6.2968	5.60	6.00
MIX 2	3	5.8000	.45826	.26458	4.6616	6.9384	5.40	6.30
MIX 3	3	5.3000	.36056	.20817	4.4043	6.1957	5.00	5.70
Total	9	5.6333	.39686	.13229	5.3283	5.9384	5.00	6.30

Descriptive Of colour analysis (retort)

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Lightness (L)	MIX 1	3	49.8267	.10263	.05925	49.5717	50.0816	49.74	49.94
	MIX 2	3	47.3000	.03000	.01732	47.2255	47.3745	47.27	47.33
	MIX 3	3	37.1367	.15503	.08950	36.7516	37.5218	36.96	37.25
	Total	9	44.7544	5.81791	1.93930	40.2824	49.2265	36.96	49.94
Redness (R)	MIX 1	3	7.8167	.08737	.05044	7.5996	8.0337	7.72	7.89
	MIX 2	3	8.4933	.07371	.04256	8.3102	8.6764	8.41	8.55
	MIX 3	3	4.6167	.03512	.02028	4.5294	4.7039	4.58	4.65
	Total	9	6.9756	1.79426	.59809	5.5964	8.3547	4.58	8.55
Yellowness (B)	MIX 1	3	24.9533	.03512	.02028	24.8661	25.0406	24.92	24.99
	MIX 2	3	23.5167	.10408	.06009	23.2581	23.7752	23.40	23.60
	MIX 3	3	15.7967	.08505	.04910	15.5854	16.0079	15.70	15.86
	Total	9	21.4222	4.26535	1.42178	18.1436	24.7009	15.70	24.99

Descriptive Of textural analysis (retort)

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
Hardness	MIX 1	3	3680.0000	46.16276	26.65208	3565.3254	3794.6746	3630.00	3721.00
	MIX 2	3	5763.6667	51.86842	29.94625	5634.8184	5892.5150	5720.00	5821.00
	MIX 3	3	3768.3333	12.01388	6.93622	3738.4892	3798.1775	3756.00	3780.00
	Total	9	4404.0000	1021.07517	340.35839	3619.1321	5188.8679	3630.00	5821.00
Cohesiveness	MIX 1	3	2.0200	.09165	.05292	1.7923	2.2477	1.94	2.12
	MIX 2	3	1.9900	.01000	.00577	1.9652	2.0148	1.98	2.00
	MIX 3	3	2.0500	.04583	.02646	1.9362	2.1638	2.01	2.10
	Total	9	2.0200	.05766	.01922	1.9757	2.0643	1.94	2.12
Springiness	MIX 1	3	1.0000	.03606	.02082	.9104	1.0896	.97	1.04
	MIX 2	3	1.4867	.75831	.43781	-.3971	3.3704	.89	2.34
	MIX 3	3	1.2633	.20108	.11609	.7638	1.7628	1.04	1.43
	Total	9	1.2500	.44576	.14859	.9074	1.5926	.89	2.34
Gumminess	MIX 1	3	7091.3333	53.15386	30.68840	6959.2918	7223.3749	7030.00	7124.00
	MIX 2	3	7044.6667	11.50362	6.64162	7016.0901	7073.2432	7033.00	7056.00
	MIX 3	3	7046.0000	3.60555	2.08167	7037.0433	7054.9567	7043.00	7050.00
	Total	9	7060.6667	35.66511	11.88837	7033.2520	7088.0813	7030.00	7124.00
Chewiness	MIX 1	3	703.6667	31.43888	18.15125	625.5682	781.7652	668.70	729.60
	MIX 2	3	682.8667	10.96646	6.33149	655.6245	710.1089	670.30	690.50
	MIX 3	3	790.9400	8.81613	5.08999	769.0395	812.8405	782.69	800.23
	Total	9	725.8244	52.56175	17.52058	685.4219	766.2270	668.70	800.23

Descriptive Statistics

	Mean	Std. Deviation	N
TREATMET 1	1.0000	.00000	21
color	8.81	1.167	21
flavour	8.71	1.384	21
chewiness	8.52	1.167	21
succulences	8.00	1.643	21
toughness	7.48	1.721	21
fibrosity	7.90	1.480	21
overally	8.95	1.161	21

Descriptive Statistics

	Mean	Std. Deviation	N
TREATMENT 2	1.0000	.00000	21
COLUR	8.81	.928	21
Flavour_A	7.86	1.493	21
Chewiness_A	8.19	.873	21
Succulence_A	7.90	1.480	21
Toughness_A	7.29	1.454	21
Fibrosity_A	7.81	.981	21
OverallAcceptance_A	8.14	1.526	21

Descriptive Statistics

	Mean	Std. Deviation	N
TREATMENT 3	1.0000	.00000	21
COLOUR	9.52	.750	21
Flavour	9.24	.944	21
Chewiness	9.00	1.095	21
Succulence	9.14	1.236	21
Toughness	8.29	1.521	21
Fibrosity	9.19	.873	21
OverallAcceptance	9.57	.978	21