Effects of Turmeric and Salt on Proximate Composition, Microbial Load and Organoleptic Quality of Treated Sun Dried *Mystus gulio*

A Thesis

By

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Examination Roll No: MS 140605

Session: 2013-2014

The Thesis submitted to the Fisheries and Marine Resource Technology Discipline in partial fulfillment of the requirements for the Degree of

Master of Science

In

Fish Processing and Quality Control

November, 2015

Effects of Turmeric and Salt on Proximate Composition, Microbial Load and Organoleptic Quality of Treated Sun Dried *Mystus gulio*

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Declaration

Effects of Turmeric and Salt on Proximate Composition, Microbial Load and Organoleptic Quality of Treated Sun Dried *Mystus gulio*

The results presented in the thesis with the above mentioned title are entirely of the candidate's own investigations and no part of the results has been accepted for any degree nor is it being concurrently submitted for any degree

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Dedicated to.....

Nayan Sarker
09 Batch
Always stay with us!!!

Acknowledgement

All the praises to the almighty Allah for blessing me to complete this thesis work for the degree of M.Sc. in fisheries from Khulna University under the Fisheries and Marine Resource Technology Discipline. I would like to express my sincere gratitude to my supervisor, **Dr. Md. Ayaz Hasan Chisty,** Professor and Head, Fisheries and Marine Resource Technology Discipline, Khulna University, for his continuous guidance, valuable suggestions and sustained supports in preparing this thesis.

I would like to express my gratitude to **Md. Noman Siddique,** Associate Professor, Fisheries and Marine Resource Technology Discipline, Khulna University, for his valuable guidance, supports and sincere appreciation. I would also like to thank **Dr. Md. Golam Sarower,** Professor, Fisheries and Marine Resource Technology Discipline, Khulna University, for giving me scope to use Microbiology Lab, Khulna University.

I would like to convey my thanks to **Md. Shahin Parvez**, Lecturer, **Sudip Debnath**, Lecturer, and **Sheik Tareq Arafat**, Lecturer of Fisheries and Marine Resource Technology Discipline, Khulna University. I am also thankful to **Md. Habibur Rahman**, Assistant Registrar (Laboratory), Fisheries and Marine Resource Technology Discipline for his cordial help in the laboratory and analytical works. I also convey thanks to all of my classmates and juniors especially for **Md. Sazu Chowdhury, Md. Imran Chowdhury, Rajib Roy, Sharmin Sultana Khushi, Monira Mohiuddin, Prema Hazra and Md. Mohim Al Mostaqur, Anupam Roy** whose inspiration and cordial help were all along with me in the hard time during the course of the present study.

Sheikh Tanvir Akhter

November, 2015

Abstract

Drying is a common method of long term fish preservation. However, the study has been conducted for 60 days to assess the proximate composition (protein, lipid, moisture and ash) total bacterial load (CFU/g) and organoleptic quality of fresh Nuna Tengra (*Mystus gulio)*, collected from local market, treated with 3% salt (by weight) and 3% salt and different levels of turmeric powder (2, 3 and 4% of body weight) prior to drying in solar-tent dryer were designated as T-1, T-2, T-3 and T-4 respectively. Proximate composition in every 10 days intervals for 60 days showed highest (P<0.05) protein content, among the treatments, in T-2 (58.97% ± 0.05) however, no difference ($P > 0.05$), with progress in storage duration, in T-2 was observed. Lipid and ash content, among the treatment, varied from 5.80% to 13.3% and 11.12% to 15.23% respectively that showed no significant difference ($P > 0.05$). Statistically ($P < 0.05$) lowest moisture content (12.56% ± 0.15) was also observed in T-2.

Total bacterial load drastically lowered in all treatments than the fresh fish (8.63×10^5 CFU/g). Control showed highest ($P < 0.05$) bacterial load in both 30th and 60th day of preservation (58.70×10^3 and 62.80×10^3 CFU/g respectively) than the others and that of the lowest ($P < 0.05$) was observed in T-4 followed by T-3 (1.78×10^3 and 1.82×10^3 and 2.14×10^3 and 2.23×10^3 CFU/g respectively). Total bacterial load gradually decreased in drying process and observed to decrease significantly ($P < 0.05$) with the increase in turmeric concentration together with salt prior to drying. However, organoleptic quality assessment of the treatments showed the highest score in T-2. Considering the nutritional value, bacterial load and organoleptic assessment it reveals that treated *M. gulio* with 3% salt and 2% turmeric prior to drying can retain it quality better for storage.

Key Words: *Mystus gulio*, proximate composition, microbial load, organoleptic assessment, salt and turmeric powder

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List of Abbreviations and non-English Words

Abbreviation	Elaboration
°C	Degree Centigrade
ACI	Advanced Chemical Industries
AOAC	Association of Official Analytical Chemists
APC	Aerobic Plate Count
CFU/g	Colony Forming Unit per Gram
et al.	And Others
FAO	Food and Agricultural Organization
Fig.	Figure
FMRT	Fisheries and Marine Resource Technology Discipline
FPQC	Fish Processing and Quality Control
g	Gram
KU	Khulna University
M. gulio	*Mystus gulio*
M. Sc.	Master of Science
mL	Microliter
ml	Mililiter
N	Normality
T	Treatment
TMAO	Tri Methyl Amine Oxide
TPC	Total Plate Count
USFDA	United States Food and Drug Administration
viz.	Namely/That is to Say/As Follows

CHAPTER ONE

INTRODUCTION

1. Introduction

1.1 Background of the study

Fish is a good source of animal protein. In our country most of the people gets about 80% animal proteins from fish (Begum *et al.,* 2010). Fishes spoil very quickly within 12-20 hours and it depends on the species and the methods of harvesting (Farid *et al.,* 2014). The people of our country are used to take fish in fresh condition. But it is difficult to maintain the fish quality in fresh condition to the consumers for long time. Moreover, the peak fishing time in Bangladesh is seasonal. During the peak catching season the catch is much higher than the consumers demand. The extra fish used to spoil at that time as there is no consumer and lack of proper preservations. There is a need to preserve and to transport fish in a systematic condition so that fish can be kept in good, acceptable condition. Fishes used to deteriorate after harvesting if it is not handled properly; spoilage and deterioration reactions begin to take place (Conne, 1995). Most of the processing or preservation operations are intended to reduce the rate of spoilage by reducing water activity of the fish (Eyo, 1986). Fresh and dried fish are a popular food in the world, including Bangladesh (Hossain *et al.,* 2012).

There are various systems for processing and preservation of fishes such as drying, freezing, smoking, canning, icing etc. About 20% of the total artisanal catch in our country is preserved by sun drying to consume by the fishermen and to market in domestic outlet (Coulter and Disney, 1987). Dry fish ('Shutki' in Bengali), is the most popular food item in Bangladesh. It supplements the major animal protein source in many areas of our country including Chittagong, Dhaka, Chandpur, Kuakata, Barisal etc. Dry fish also has international market. It is exported to many countries of the world where the main consumers are immigrants and workers of the developing countries. Drying is a traditional method of preserving fish being they have been used for centuries and dried salted products are popular in many areas, particularly in Africa, South East Asia and Latin America. It is found that dried fishes often are an alternative to fresh fishes in many places like Chittagong, Patuakhali, Dublar chor, Chandpur etc. (Laureti, 1998). Dried fish contributes significantly in our economy. The demand of dried fish depends on its appearance, flavor and taste. But in many cases it becomes difficult to get similar flavor, taste or texture from dried fishes. In Bangladesh most of the market samples become slightly odorless and some lose the shelf life because of rancidity that lead to produce

bitter tastes. Nutritional composition also varied at large scale in different dried fish products. The physical and organoleptic qualities of the traditional sun dried products available in the market are not satisfactory for human consumption (Kamruzzaman, 1992; Khan, 1992; Saha, 2003; Reza *et al.*, 2008). There are frequent complaints from the consumers about the quality of the products and the major problems associated with sun drying of fish are infestation of the products by the flies and insects larvae during drying and storage, contaminants and spoilage. Approximately 10-35% of the dried fishes are spoiled by insect attack in the marine areas (Doe *et al.,* 1977; Ahmed *et al.,* 1978). Except insect infestation, a big amount of dried fish spoiled every year due to proper drying, preservation and storage facilities particularly during the glut season (Neuschler, 1988). The dried fish are normally kept in gunny bags or in bamboo baskets as a traditional storage in our country which is not favorable environmental condition. During the monsoon, the average relative humidity in Bangladesh is over 85%. So, dried fish in this period absorbs moisture from air, resulting in a higher water activity which is favorable for microbial growth. .

Fish drying methods varies from species to species based on the type of end product and its quality requirement. In some countries, the fish are boiled before being dried. As a traditional practice drying of fish in sun is followed worldwide (Sachithananthan *et al.,* 1985). Sun drying of fishes is the most suitable and cheapest method of preservation (Eyo, 1986). But major problems with traditional sun drying are losses of quality due to contamination and infestation by animals. Fish can be dried without salting or after salting. In Bangladesh, fish is usually salt dried without preliminary treatment. Salt retards bacterial action and aids the removal of water by osmosis (Begum *et al.,* 2012b; Begum, 2012). When fish are salted before drying, the moisture content ranges between 35 and 45% in the meat as a function of salt concentration, which inhibit bacterial growth (Chinivasagm and Vidanapthirama, 1982).

Fishes can be preserved or processed by using turmeric powder, lemon juice, ginger etc. which is termed as bio-preservation. Bio-preservation is the use of natural or controlled microbiota and/or antimicrobial compounds, as a way of preserving food extending its shelf life and retarding microbial activity with proper proximate composition. Beneficial bacteria or fermented products produced by these bacteria are used in bio-preservation to control spoilage and render pathogens inactive in food. It is a benign ecological approach

which is gaining increasing attention (Ananou *et al.,* 2007). Now-a-days it has been observed that fish treated with several bio-preservation like turmeric, lemon juice, lemon leaves extraction, ginger etc. or other cooking ingredients showed better performance than our traditional processing method. In Bangladesh, turmeric is easily available and is considered as one of the important ingredient for cooking any kind of dish. Even in some parts of Bangladesh (Chittagong, Patuakhali, Dublar Chor etc.), rural people usually use turmeric powder for short time preservation of small sized fishes. But, there is very little scientific information about the use of turmeric in fish preservation. Turmeric is a member of the ginger family Zingaberaceae. It is a natural spice, obtained from the root *Curcuma longa* (Peirce, 1999). It is bright yellow in color and has been used as a coloring agent in food in USA. It has been used for thousand years as a spice, a food preservative and also for medicinal properties in India (Eigner and Scholz, 1999). Turmeric is extremely acclaimed source of functional food constituents like Curcumin (Prathapan *et al.,* 2009). Even though turmeric has several health improving benefits, still plenty research is needed for the support of powder turmeric being part of our food formulations. Traditionally processed fish products are very susceptible to microbiological damage, which can cause damage to processed products by pathogenic bacteria or fungi, or by toxins produced. For this reason microbial load determination is very crucial to evaluate the quality of fishes. Microbiological quality indices, namely standard plate count, presence of *Oibrio cholera, Salmonella species* and *faecal coliforms*, were determined at specific points in the preparations of frozen shrimp (Christofer, 1978). Microbiological attack starts rapidly after catching and for this reason preservation or processing is needed to defend the deterioration of the fish quality.

Fresh Nuna Tengra fish was collected to conduct the study. The live fresh fishes were collected for the research purpose. *M. gulio*, the Long Whiskers Catfish, is a species of catfish of the family Bagridae. This species is commercially important and available in brackish and fresh water in our country especially in the southern part. If these species could be preserved it would be a great opportunities to consume these fishes after a longer period of time with retained properties of protein content. There are many research published about the drying of freshwater species i.e. tengra (*Mystus vittatus*), Shoal (*Ophiocephalus vagus*), taki (*Channa punctatus*), chanda (*Chanda nama*), kachki (*Coricaso borna*) and churi (*Trichuirus haumela*) etc. But there is no such research about salt and turmeric preservation of *M. gulio* and for this reason this species is selected for the current study considering its commercial value in the southern part of the country.

Among various indigenous fish species of Bangladesh Nuna tengra (*M. gulio*) is common and popular because of their nutritional value and taste. These are a great source of protein, lipid, minerals etc., which are essential to human development and remedy for various diseases. But availability of this vital source of nutrients largely depends on storage method (Hardy and Smith, 1976). There are various storage and preservation methods such as freezing, salting, roasting, drying, frying etc. Storage time and temperature are major factors, which affect the rate of loss of quality and shelf life of fish (Whittle, 1997). Moreover various storage methods affect the quality of fish product in a different way.

Now-a-days consumer wants to know and ensure the nutritional value of the products what they are eating. Although a good number of work on the biochemical composition of fishes in Bangladesh have been done by many researchers viz. (Rubbi *et al.,* 1987, Mollah *et al.,* 1998, 2000, Nurullah *et al.,* 2002, 2005, Islam *et al.,* 2003, Mazumder *et al.,* 2008). But bio-preservation of dried fishes both freshwater and marine species were not focused. So the present investigation carried out in order to assess the effects of turmeric at different concentration as a bio-preservative on dried *M. gulio* on the context of Organoleptic Quality, Proximate Composition and Microbial activities. Organoleptic Quality, Proximate composition (Protein, lipid, moisture and ash) and Microbial load (Total Plate Count) were assessed through laboratory analysis.

1.2 Objectives of the experiment

The study has been taken to observe:

- the changes of Proximate Composition (Protein, moisture, lipid and ash) of sun dried *M. gulio* (Nuna Tengra) treated with different inclusion levels of salt and turmeric powder at different days of storage
- the ogranoleptic changes of treated fish
- the microbial load (Aerobic Plate Count) of treated fish

CHAPTER TWO

LITERATURE REVIEW

2. Literature Review

A large body of information is available regarding the natural sun drying of fish. Unfortunately precise information about the influence of salt with turmeric powder on the drying performance and quality changes during storage remained unknown. Moreover there are little information about the proximate composition and Microbial activity (TPC) of dried *M. gulio*. There is no research about Bio-preservation of *M. gulio* including proximate composition and Microbial activity (TPC) treated with turmeric powder. The literature thus reviewed here necessarily includes studies conducted with dried fishery products prepared from other fishes, which are considered pertinent to the present study.

Akter *et al.,* 2013 studied the performance of turmeric and salt treated product with various treated products of tengra (*Mystus vittatus*). The salt and turmeric treated product include a combination of salting and drying process and addition of turmeric with salt as preservatives. The other three treated products included turmeric, salted and unsalted products. It was also observed that the experimentally sun dried tengra fish in four treated condition in laboratory, here salted fish contained 2.0 to 3.0% salt, salt and turmeric treated fish contained 2.5 to 3.5% salt and turmeric fish contained 1-2% turmeric.

Flowra *et al.,* 2012 studied to assess the proximate composition of five dried fish samples of *Mystus vittatus, Channa punctatus, Chanda nama, Corica soborna* and *Trichuirus haumela.* The moisture content ranged from 14.06% to 24.58%, protein varied between 44.08% to 65.65% (moisture basis) and 53.45% to 76.39% (dry matter basis), lipid content of the selected dried fishes ranged from 1.91% to 17.76% (moisture basis) and 2.31% to 21.54% (dry matter basis). Ash content varied from 9.63% to 22.73% (moisture basis) and 11.21% to 28.15% (dry matter basis).

Proximate composition of solar tunnel dried SIS like Mola, Dhela, Punti, Batashi, Tengra, Chapila were reported by Nurullah 2005 where moisture content ranged from 14.38-18.48% protein content ranged from 57.24-60.40%, lipid content ranged from 9.00-12.13%. The author also reported also reported that Aerobic Plate Count (APC) of some traditional dried SIS products ranged from 1.45 to 2.52 $\times 10^4$ cfu/g.

Abdul Hei and Ch Sarojnalini, 2012 studied the proximate composition, of some smoke-dried hill stream fishes *Neolissochilus stracheyi, Labeo pangusia, Semiplotus manipurensis, Schizothorax rechardsonii* and *Ompok bimaculatus* were determined. The range of moisture contents in all the fishes was between 9.36±0.01% and 15.77±0.02%. The highest protein level (71.31±3.11%) was found in *Schizothorax rechardsonii* and the lowest (30.51±2.19%) in *Ompok bimaculatus*. The highest lipid content (19.63±.88%) was found in *Ompok bimaculatus* and the lowest (6.68±.34%) in *Schizothorax rechardsonii*. The ash content was between 4.33±0.02-5.55± 0.00% in all fishes.

Lal 2012 reported that turmeric powder contain 6.8gm ash, 8.9 gm lipid, 390 KCal carbohydrate, 8.5 gm protein and so on. The research also reports that turmeric powder inhibits the growth of a variety of bacteria, parasites and pathogenic fungi.

Sultana *et al.*, 2011 conducted biochemical analysis of seven dried SIS fishes of the river padma in rajshahi. The fishes are *Chanda baculis, Chanda ranga, Amblypharyngodon mola, Oxygaster bacaila, Clupisoma atherinoides, Corica soborna, Mystus vittatus*. The maximum moisture content was found in *Chanda ranga* (13.50%) and the minimum in mixed SIS fishes (11.65%). The maximum protein content was recorded in the mixed SIS fishes (72.45%) and the minimum in *Chanda ranga* (52.65%).

Reza *et al.*, 2008 studied the production of safe and high quality dried fish products by fish drying process in a Hohenheim-type solar tunnel dryer. They studied five commercially important tropical marine fish species in the Bay of Bengal such as silver jewfish, Bombay duck, big-eye tuna, Chinese pomfret and ribbon fish. They observed moisture content of the fish samples reached 16% after 36 and 32 hrs of drying at temperature ranges of 45 to 50 and 50 to 55°C, respectively. They also found the aerobic pate count of all the final dried products were 1.8×10^3 to 2.6×10^4 , 2.6×10^3 to 2.6×10^4 , 5.4×10^4 to 6.0×10^5 , 8.0×10^2 to 3.0×10^5 and 5.0×10^3 to 1.0×10^5 cfu/g respectively.

Mansur *et al.*, 1989 conducted investigation on the quality of dried fish where they stated the composition of traditional dried *Labeo rohita* as 26.20% moisture, 59.95% protein, 10.80% lipid and 12.79% ash. For *Barbus sarana, Channa striaus* and *Gudusia chapra* these values were 16.71, 59.29, 13.26 and 10.54; 10.77, 70.29, 2.87 and 12.97; 18.32, 51.52, 11.76 and 16.73% respectively.

Ali *et al.,* 2007 observed that organoleptic and microbiological assessment of ten commercially important dried and fresh fishes. They showed Standard Plate count of seven dried fish samples like Loytta, Gang Tengra and Phasa ranged from 4.23 to 7.8×10^3 cfu/g, five contained 3.2 to 6.07×10^4 cfu/g, while the remaining two samples (Shaplapata and Churi) SPC of 2.26 and 2.77 cfu/g respectively.

Protein denaturation is caused by addition of excess amount of salt to the fish suggested by several reports. This was calculated in cod muscle during brining where the soluble protein reduced gradually from 55% to 30% and after 18 days it reached to a constant level Van-Klaveren and Legendre, 1965.

The moisture content of the dried product of Silver Jew fish (*Johnius argentatus*), Ribbon fish (*Trichiurus haumela*), Bombay duck (*Harpodon nehereus*), Chinese Pomfret (*Stromateus chinensis*) and Big-eye tuna (*Scomberomorus gottatus*) products ranged from 18.0 to 29.8% with the highest value in Big-eye tuna collected from retail market and the lowest in Silver jewfish. The range of protein contents was 42.51 to 56.58%. Lipid and ash content were in the range of 1.97 to 8.08% and 15.5 to 26.84%, respectively (Reza, 2009). The protein content of sun dried shutki of both marine and freshwater fishes varied from 55.30 to 74.18% in *Labotes surinamensis* (Katkoi) and *Channa marulius* (Gazer), respectively Qudrat-I-Khuda *et al.,* 1962.

Latifa *et al.,* 2014, conducted study on biochemical (proximate and chemical) composition and sensory evaluation during storage at refrigeration temperature (4°C). There was a general decline in sensory characteristics i.e. color, texture, odor, general appearance and mean of acceptability of fish- product during storage. The differences in the biochemical composition of the fresh and smoke-dried samples were statistically significant ($p<0.05$). Moisture (%) increased significantly whereas protein (%), lipid (%) and ash (%) content significantly decreased. The initial value of moisture, protein, lipid and ash of freshly smoke-dried Chapila, Kaika and Guchi-Baim fish was 6.21%, 45.93%, 30.81% and 18.95%, 8.24%, 63.04%, 6.71% and 22.52% and 6.97%, 59.22%, 11.67% and 22.54% respectively.

The moisture and protein contents of solar tunnel dried products were in the range of 13.71%-19.30% and 49.32%-65.30%, respectively. Lipid content of solar tunnel dried products was in the range of 11.96%-18.07%, while ash content was 6.80% to13.28%. Moisture, protein, lipid and ash contents of the solar tunnel dried product of silver jewfish (*Johnius argentatus*), ribbon fish (*Trichiurus haumela*), bombay duck (*Harpodon nehereus*) varied in the range of 11.48 to16.83%, 58.51 to 68.49%, 6.08 to 8.62% and 13.05 to 14.88%, respectively Mehbub, 2004.

The moisture content of the dried product of Silver jewfish (*Johnius argentatus*), ranged from 18.0 to 29.8%. The range of protein contents was 42.51 to 56.58%. Lipid and ash content were in the range of 1.97 to 8.08% and 15.5 to 26.84%, respectively Reza, 2002. Cutting 1962 reported that the chief alternation caused by drying is the reduction of moisture which resulted in an increase in protein and therefore, changes in food value in terms of unit amount of fish. But the changes in food value during curing varied greatly depending on the type of fish and the method of processing employed.

CHAPTER THREE

MATERIALS and METHODS

3. Materials and Method

3.1 Sample Collection

To conduct the research experiment Nuna Tengra (*Mystus gulio*) was collected from Gollamari fish Market, Khulna at fresh condition. After collection the sample was immediately taken to the Nutrition and Microbiology Laboratory of Fisheries and marine Resource Technology Discipline (FMRT), Khulna University, Khulna, to analyze the sample. The average weight and length of the *M. gulio* was 33.43±4g and 12.20±2cm respectively. At first the fishes were carefully washed with tap water. Number of sample was 20 pieces for each treatment.

3.2 Sample Preparation

3.2.1 Dressing/Gutting

Prior to the experiment the fishes were gutted and gills, viscera were removed.

3.2.2 Washing

After gutting, the raw materials were washed again with tap water to remove blood, slime and other undesirable substances.

3.3 Treatment preparation

3.3.1 Salt and turmeric

To conduct the experiment salt (ACI salt, ACI Limited) and commercial turmeric powder (Radhuni, A product of Square Food and Beverage Ltd.) were collected from local market. Salt and turmeric powder was mixed with sufficient amount of water and rubbed outer the fish body.

There were three replications under four treatments for the experiment. The treatments were termed as follows:

Table-1: Treatments of the current study

SL.	Treatments	Description
1	Control	Dried fish without salt and turmeric powder
2	T-1	3% salt of fish body weight
3	T-2	3% salt with 2% turmeric powder of fish body weight
4	T-3	3% salt with 3% turmeric powder of fish body weight
5	T-4	3% salt with 4% turmeric powder of fish body weight

3.4 Drying

To dry the fish a solar tent dryer was made using locally available materials. The dryer was made with wooden frame and covered with transparent polythene sheet which was attached with the frame of the dryer to avoid outside contamination and to protect the samples from the attack of bird, rodent and fly infestation. The size of the dryer was 5.5 feet × 3 feet × 4 feet at every corner of the polythene sheet. Small pores were made to facilitate the air flow. Fishes were kept in sun regularly during day time from 8.30am to 5.30pm for 10 days (22 to 31 may 2015). Prior to treatment the dried fish were kept into airtight polythene bags. The samples for the present study were prepared at fish Nutrition and Microbiology lab of Khulna University. The proximate composition of the treated samples was analyzed with every ten days intervals. The microbial load and organoleptic assessment were observed for three times, one, at the beginning of the experiment second one was at 30 days and last one was counted at 60 days.

3.5 Proximate Composition Analysis

Proximate composition analysis of protein, lipid, moisture and ash were carried out according to the methods of AOAC (1980) with certain modifications as described below.

3.5.1 Moisture determination (%)

Moisture was determined by complete drying of the sample at 105^{0}C. The loss in weight of the sample is the measurement of moisture content. For determining moisture a porcelain crucible was cleaned, dried and then the constant weight of the crucible was taken. Sample was placed in the crucible and weight was taken. Difference between the weights gave the weight of the sample. The crucible with sample was put in a controlled oven (N40C, Japan) and was dried at 105^{0}C for 24 hours and was weighed in electric balance (B303S, Japan) several times till the constant weight was achieved.

Calculation

The percentage of moisture content was calculated by the following formula:

$$\text{Moisture (\%)} = \frac{\text{Weight of the sample (g) - Weight of the dried sample (g)}}{\text{Weight of the sample}} \times 100$$

(Pearson, 1976)

3.5.2 Ash Determination (%)

Ash content was determined by igniting the sample in a Digital Muffle Furnace (DMF-05, Korea) at a temperature of 550°C for 6 hr. The sample was then cooled in a desiccator. The average weight in percentage of each sample of the remaining material was taken as that of ash. For determination of ash content the following formula was used-

$$\text{Ash content (\%)} = \frac{\text{Weight (g) of Ash}}{\text{Weight (g) of the sample}} \times 100$$

(Pearson, 1976)

3.5.3 Protein determination (%)

All the ingredients were homogenized separately by grindings. The protein level of each ingredient was determined according to the AOAC, 1980.

The procedure involves in two steps: (a) digestion of the sample to convert the N to ammonium sulphate and (b) determination of nitrogen in the digested sample through distillation and titration. About 0.2-0.5g sample was taken in a Kjeldahl flask and about 2g resolvent was added into the flask. About 5ml of concentrated sulfuric acid was added in to the flask slowly. Then the flask was kept on to a Kjeldahl nitrogen digesting apparatus (model No. OSK 8408A, OGAWA SEIKI CO. Ltd.) and heated until a clear digestion mixture appeared. After digestion, the flask was removed from the digestion unit and kept at room temperature until cooling. After cooling the digestion mixture, 70ml distilled water was poured slowly along the flask's inner wall and 0.5g of sandy zinc was also added to the mixture. About 25ml of 33-40% sodium hydroxide (NaOH) solution (containing 1% potassium sulfide) was poured slowly along the flask's inner wall and washed down the remaining solution on the mouth with a small amount of water. The flask was then placed to the Kjeldahl nitrogen distillation apparatus (Model No. OSK 8416A, OGAWA SEIKI CO. Ltd.) and turned the switch on. Before connecting the sample flask with the distillation plant, 10-20ml of 2% boric acid was taken in another Erlenmeyer flask (conical flask) and 2-4 drops of Tashiro's indicator (80mg methyl red and 20mg methylene blue in 95% ethanol and make up to 100ml with 95% ethanol) was added into it. Then the distillation tube was poured into the Erlenmeyer flask so that the end of the glass tube was immersed in the boric acid solution.

Distillation procedure was continued for about 30 minutes to obtain about 30ml distilled solution. After completion of distillation, the solution was titrated with 0.1N hydrochloric acid (HCl).

$$\% \text{ Total nitrogen (\% N)} = \frac{\text{Titrant (ml)} \times \text{Strength of titrant} \times 0.014}{\text{Weight of sample (g)}} \times 100$$

$$\% \text{ Crude Protein} = \% \text{ N} \times 6.25$$

(AOAC, 1980)

3.5.4 Lipid

For lipid determination 2-5g of sample was taken and mixed with 100ml of chloroform and methanol at a ratio of 2:1. Then the mixture was homogenized by using an electric homogenizer for 2 minutes. The resultant mixture was poured into a separation tube through filter paper. Then 50ml of distilled water was added and shook the tube which turned the solution into milky color. The solution was kept in separation funnel for 8-16 hours. Another beaker was dried in the oven weighted and poured clear extracted solution which contain lipid. Beaker was then kept on the hot plate (Stuart Scientific heater) at 70^0C until the evaporation of chloroform and methanol. The percentage of lipid count was calculated by the following equation:

$$\text{Percentage (\%) of Lipid} = \frac{\text{Weight of the residue}}{\text{Weight of sample}} \times 100$$

(Horowitz, 1984)

3.6 Microbial analysis

3.6.1 Aerobic Plate Count

Microbiological analysis was done according to the Bacteriological Analytical Manual of United States Food and Drug Administration (USFDA). Total Plate Count (TPC) or Aerobic Plate Count (APC) was included in current study.

3.6.3.1 Sterilization of equipments

Test tubes, Petri dishes, conical flask, plastic tips and other glassware were sterilized by autoclaving at a temperature of 121°C and a pressure of 15 pound per square inch for about 1 to 2 hours.

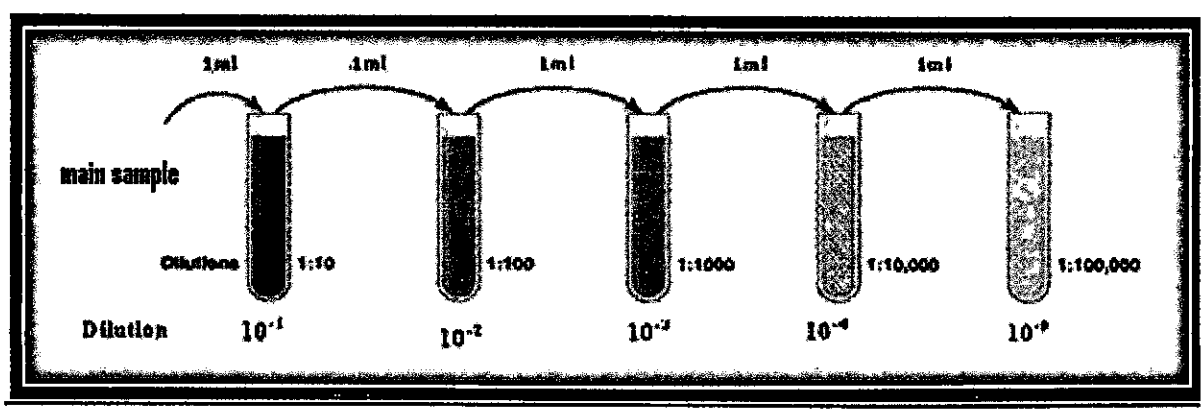
3.6.3.2 Media preparation

Media was being prepared by compounding require individual ingredients or, more conveniently, by adding water to a dehydrated product which contained all the ingredients. Practically, all media were available commercially in powdered form.

- Definite amounts of Plate Counting Agar (2.5g) were being accurately weighted
- These would take in separate volumetric flask (500ml) containing distilled water (half of the required volume)
- Then the final volume (500ml) being adjusted by pouring additional distilled water.
- Then the volumetric flasks kept in autoclave for sterilization. Autoclave has to be done at a temperature of 121°C for about 1 to 2 hours.
- After autoclave, the agar media was kept in the bio-safety cabinet for 20-30 minutes for cooling and then transferred in required number of petri dishes by 25ml volume for preparing plates.

3.6.3.3 Sample Preparation & Dilution (Water Samples)

1 ml of sample water was taken especially from the each sample and was transferred to cotton plugged bottle containing 9 ml distilled water. The sample was mixed properly by shaking the bottle carefully. Then the total amount became 10 ml. This made 1st decimal dilution (0.1). In this way five dilution tubes with the dilution strength, 10^{-1} through 10^{-5} were made **(fig-1).**



http://www.slideshare.net/sarah_jumali/serial-dilution, 15 Nov, 2015, 8.30 pm

Figure: 1: Serial dilution of sample

The pour plate method requires use of 1 mL, 0.1 mL, and 0.01 mL or 0.001 mL of sample. The difficulty measuring and working with the two smaller volumes, 0.01 and 0.001 mL, require the use of sample dilutions.

3.6.3.4 Pour Plating

- 1 ml of the sample homogenates from the dilution tube from each samples were transferred by pipette into each of the appropriately marked and sterile duplicate Petri dishes (size 100 ml)
- Approximately 20 ml of the plate count agar (kept at 45^0C in a water bath) was poured into each Petri dish within shortage possible time of original dilution
- The sample dilutions and agar media were mixed thoroughly and uniformly by rotating the Petri dishes clockwise and anticlockwise
- Then the agar media were allowed to solidify
- Finally the solid agar media were allowed to freeze for 30 min

3.6.3.5 Incubation

The Petri dishes with solidified agar were incubated at 37^0C for 24 hours in the incubator.

3.6.3.6 Plate Counting

After incubation, the plates were analyzed. Analysis, in this case, means simply counting the entire colony forming units (CFU). To get reliable results with the spread plate method, only those plates were counted that produced between 30 - 300 CFUs. For ease of counting, the plates were marked into quadrants and count each quadrant separately.

1) Dividing the number of CFUs counted by the dilution factor and adjusts for the amount of sample actually plated. Reporting the number of colonies as CFU/g = Number of colonies on plate × reciprocal of dilution of sample.

2) Samples were reported on weight basis.

3) Estimating the number of microorganisms in total sample.

3.7 Organoleptic Quality Assessment

The organoleptic quality evaluation method used in this study was based on the procedure of Shewan and Ehrenberg, (1977), with some modification. To assess the organoleptic quality a panel of three members was formed. The average age of the panel members was 29. Samples from all the treatment were taken for organoleptic test. The assessment was done at 10, 30 and 60 days of the experiment. Prepared Score sheet, for the assessment was supplied to each panel members. Six quality factors were considered to assess the organoleptic quality.

Table-2: Organoleptic assessment indicators

Skin Appearance	Texture	Color	Odor	Score
Very good	Firm and Flexible	Very good	Very good	10
Good	Good	Good	Good	8
Moderately good	Moderately good	Moderately good	Moderately good	6
Moderately Bad	Moderately fragile	Moderately Bad	Moderately Rancid	4
Bad	Fragile	Bad	Rancid	2
Very Bad	Very fragile	Very Bad	Very Rancid	0

3.8. Data Analysis

Microsoft Excel (version 5.0, Microsoft Inc, USA). and SPSS-17 were used to analyze and interpret the data. At first the date were input in Microsoft Excel. The data was exported to SPSS-17 for ANOVA Test, Homogenity Test (HSDa) and Descriptive Test. The Tables and graphs were generated from Microsoft Excel using SPSS-17.

The total procedures were as follows:

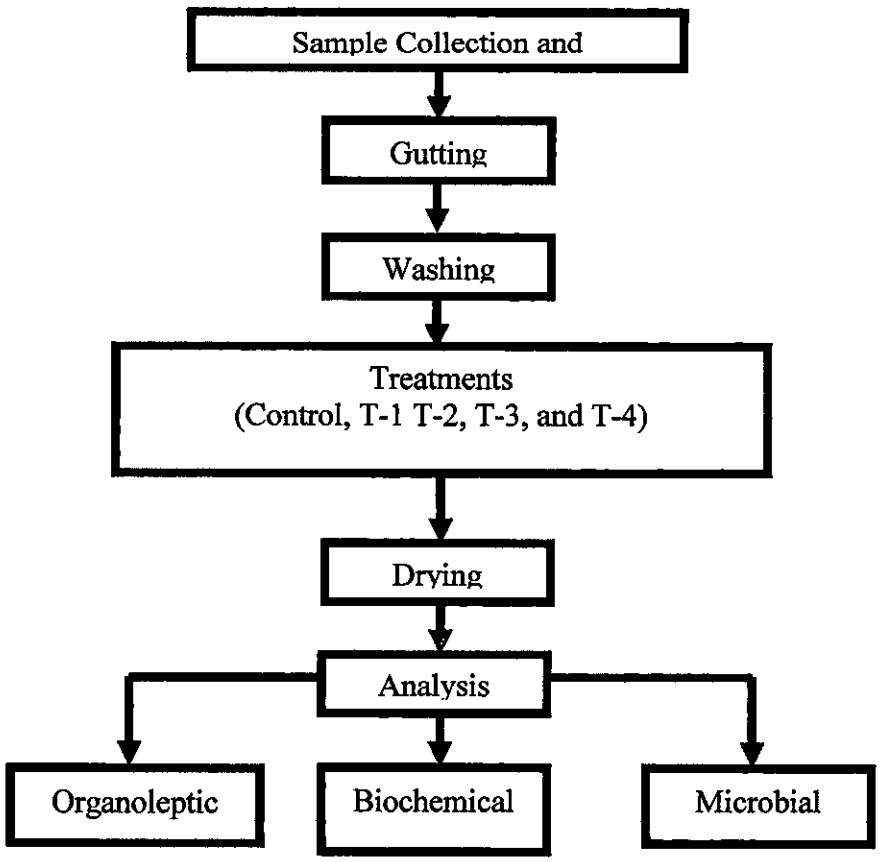


Figure 2: Flow chart of Materials and Methods

CHAPTER FOUR

RESULTS

4. Result

4.1 Proximate composition of raw Nuna Tengra

Proximate composition of raw fish analyzed. The protein, lipid, moisture and ash contents of the raw fish was found 14.45%, 6.43%, 76.47% and 4.25% respectively (mean of triplicates). The moisture content of raw fish was higher than the other components (Fig.3).

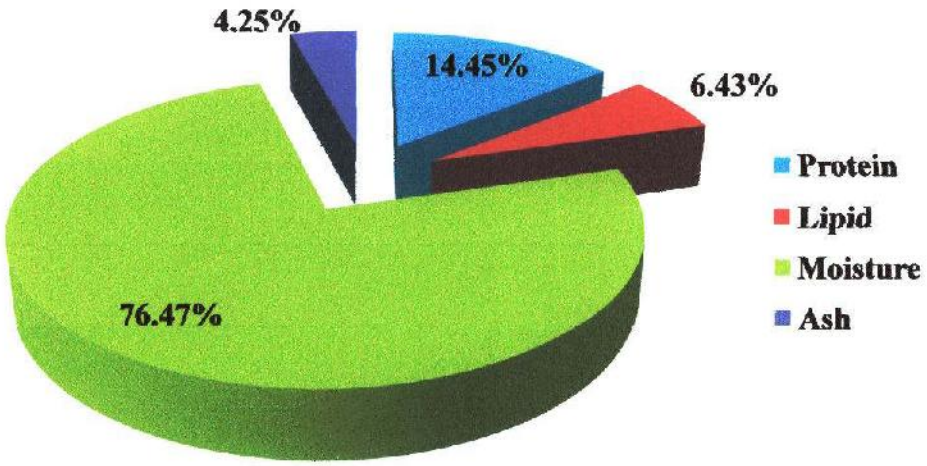


Figure 3: Proximate composition of raw Nuna Tengra

4.2 Proximate Composition of Treated Tengra

4.2.1 Crude Protein

Crude protein content among the treatments at different day intervals was analyzed. Significantly ($P < 0.05$) highest protein content (58.97% ± 0.05), after 10 days of storage, was observed in T-2 and the lowest (56.32% ± 0.40, $P < 0.05$) was observed in T-1 (Table-3). However, no statistical difference ($P > 0.05$) among the treatments was observed after 20 days of storage. After 30 days of storage, comparatively higher protein content was observed in T-2 and T-4 (58.01% ± 0.17 and 57.67% ± 0.10 respectively) that showed difference ($P < 0.05$) with the other treatments. In 40 days significantly ($P < 0.05$) highest protein content (57.81% ± 0.13) was observed in T-2 and lowest (54.93% ± 0.07; $P < 0.07$) was observed in T-1. The highest protein content was observed in T-2 (57.46% ± 0.10 and 56.97% ± 0.18) after 50 and 60 days storage period respectively which was significantly different ($P < 0.05$) from the other treatments. There was no

significant difference ($P > 0.05$) in control, T-3 and T-4 at 40, 50 and 60 days respectively.

Table-3: Protein content of Treated Tengra at different treatments*

Duration	Control	3% Salt Only (T-1)	3% Salt+2% Turmeric (T-2)	3% Salt+3% Turmeric (T-3)	3% Salt+4% Turmeric (T-4)
Day 10	$57.55^{c}\pm0.07$	$56.32^{d}\pm0.40$	$58.97^{a}\pm0.05$	$58.15^{b}\pm0.07$	$57.87^{bc}\pm0.04$
Day 20	$57.69^{a}\pm0.02$	$57.18^{a}\pm0.38$	$57.70^{a}\pm0.35$	$57.73^{a}\pm0.04$	$57.66^{a}\pm.34$
Day 30	$57.21^{b}\pm0.05$	$55.25^{c}\pm0.06$	$58.01^{a}\pm0.17$	$57.18^{b}\pm0.05$	$57.67^{ab}\pm0.10$
Day 40	$56.72^{b}\pm0.04$	$54.93^{c}\pm0.07$	$57.81^{a}\pm0.13$	$56.80^{b}\pm0.05$	$57.04^{b}\pm0.13$
Day 50	$56.00^{b}\pm0.39$	$54.11^{c}\pm0.07$	$57.46^{a}\pm0.10$	$55.85^{b}\pm0.05$	$56.26^{b}\pm0.14$
Day 60	$54.95^{c}\pm0.27$	$53.07^{d}\pm0.12$	$56.97^{a}\pm0.18$	$55.88^{b}\pm0.38$	$55.22^{c}\pm0.08$

*Values are Mean ± SE (n=3). Different letter superscripts in the same row show significant difference ($P < 0.05$).

4.2.2 Lipid

Lipid content was analyzed among the treatments at 10 days intervals (Table-4). At day 10 comparatively highest lipid contents were observed in T-4 (12.25% ± 0.12), T-3 (11.99% ± 0.01) and T-2 (11.47% ± 0.07) respectively which significantly differ ($P < 0.05$) from T-1 (9.61% ± 0.06) and control (9.92% ± 0.72) containing lowest protein content. Highest lipid content after 20 days was found in T-4 (12.20% ± 0.17) which differ significantly from lowest content at T-1 (9.40% ± 0.68) and control (9.36% ± 0.23).

Table-4: Lipid content of *M. gulio* at different treatments*

Duration	Control	3% Salt Only (T-1)	3% Salt+2% Turmeric (T-2)	3% Salt+3% Turmeric (T-3)	3% Salt+4% Turmeric (T-4)
Day 10	$9.92^{b}\pm0.72$	$9.61^{b}\pm0.06$	$11.47^{a}\pm0.07$	$11.99^{a}\pm0.01$	$12.25^{a}\pm0.12$
Day 20	$9.36^{b}\pm0.23$	$9.40^{b}\pm0.68$	$11.12^{ab}\pm0.07$	$11.16^{ab}\pm0.56$	$12.20^{a}\pm0.17$
Day 30	$9.32^{bc}\pm0.64$	$8.02^{c}\pm0.07$	$10.55^{ab}\pm0.11$	$11.07^{a}\pm0.09$	$11.45^{a}\pm0.21$
Day 40	$8.71^{cd}\pm0.64$	$7.86^{d}\pm0.07$	$9.91^{bc}\pm0.05$	$10.54^{ab}\pm0.03$	$11.65^{a}\pm0.09$
Day 50	$7.44^{c}\pm0.36$	$7.32^{c}\pm0.10$	$9.25^{b}\pm0.07$	$10.05^{ab}\pm0.07$	$10.18^{a}\pm0.09$
Day 60	$5.80^{c}\pm0.35$	$7.07^{b}\pm0.06$	$8.67^{a}\pm0.09$	$9.25^{a}\pm0.06$	$9.35^{a}\pm0.11$

*Values are Mean ± SE (n=3). Different letter superscripts in the same row show significant difference ($P < 0.05$).

Significantly ($P < 0.05$) highest lipid content, after 30, 40 and 50 days were observed in T-4 though there were no statistical difference ($P > 0.05$) between T-3 and T-4. But lipid content of T-4 was significant ($P < 0.05$) in comparison to the lowest lipid content at control and T-1 after 30, 40 and 50 days respectively. Significantly ($P < 0.05$) lowest lipid content (5.80% ± 0.35), after 60 days of storage, was observed in control. Comparatively highest lipid content at 60 days was observed in T-4 (9.35 % ± 0.11), T-3 (9.25% ± 0.06), and T-2 (8.67% ± 0.09) without statistical difference ($P > 0.05$).

4.2.3 Moisture

Moisture content of *M. gulio* at different storage period was analyzed (Table-5). Significantly highest moisture content was observed in control (17.75% ± 0.49) and T-1 (16.68% ± 0.35) respectively at 10 days which were statistically different ($P < 0.05$) from the other treatments. At 20 and 30 days significantly ($P < 0.05$) highest moisture content was observed in control (18.87% ± 0.06 and 19.35% ± 0.05 respectively) and lowest ($P < 0.05$) was observed in T-3 (13.30% ± 0.07 and 13.20% ± 0.67) and T-2 (12.59% ± 0.04 and 13.55% ± 0.65) respectively.

Table-5: Moisture content of *M. gulio* at different treatments*

Duration	Control	3% Salt Only (T-1)	3% Salt+2% Turmeric (T-2)	3% Salt+3% Turmeric (T-3)	3% Salt+4% Turmeric (T-4)
Day 10	17.75^{a}±0.49	16.68^{a}±0.35	12.56^{c}±0.15	13.22^{c}±0.06	15.20^{b}±0.12
Day 20	18.87^{a}±0.06	16.79^{b}±0.08	12.59^{c}±0.04	13.30^{c}±0.07	16.22^{b}±0.61
Day 30	19.35^{a}±0.05	17.55^{b}±0.08	13.55^{c}±0.65	13.20^{c}±0.67	16.50^{b}±0.07
Day 40	20.12^{a}±0.06	18.11^{b}±0.12	14.25^{d}±0.07	15.12^{c}±0.11	17.84^{b}±0.08
Day 50	20.95^{a}±0.05	18.23^{b}±0.12	15.75^{c}±0.08	16.21^{c}±0.05	18.25^{b}±0.72
Day 60	22.15^{a}±0.12	20.10^{c}±0.12	16.25^{e}±0.08	18.22^{d}±0.12	21.32^{b}±0.05

*Values are Mean ± SE (n=3). Different letter superscripts in the same row show significant difference ($P < 0.05$).

Lowest moisture content at 40 days was observed in T-2 (14.25% ± 0.07) which was significant ($P < 0.05$) than the other treatments and highest ($P < 0.05$) was observed in control (20.12% ± 0.06). At day 50 day comparatively lowest moisture content was

experimented in T-3 (16.21% ± 0.05) and T-2 (15.75% ± 0.08) which was significant to the others ($P < 0.05$). After 60 days of storage period lowest moisture content was calculated in T-2 (16.25% ± 0.08) and highest was calculated in control (20.95% ± 0.05) which were statistically different ($P < 0.05$) from the other treatments.

4.2.4 Ash

The below Table-6 describes the ash contents with standard error of five treatments in 10 days interval. At day 10 highest ash content was observed in T-4 (15.23% ± 0.08) which was significant ($P < 0.05$) than the other treatments control. There was no statistical difference ($P > 0.05$) at day 20 among the treatments. At day 30 comparatively highest ash content were observed in T-4 (14.36% ± 0.09) and T-3 (14.28% ± 0.09) which was significantly different ($P < 0.05$). Lowest ash content at day 30 was observed in control (12.84% ± 0.08). At day 40 highest and lowest ash contents were observed in T-4 (13.95% ± 0.05) and control (11.56% ± 0.15) at an amount of 13.95% ± 0.05 and 11.56% ± 0.15 which was statistically different ($P < 0.05$).

Table-6: Ash content of *M. gulio* at different treatments*

Duration	Control	3% Salt Only (T-1)	3% Salt+2% Turmeric (T-2)	3% Salt+3% Turmeric (T-3)	3% Salt+4% Turmeric (T-4)
Day 10	13.84^{d}±0.06	14.27^{cd}±0.16	14.56^{bc}±0.10	14.85^{ab}±0.09	15.23^{a}±0.08
Day 20	13.65^{a}±0.20	13.75^{a}±0.20	14.24^{a}±0.06	15.22^{a}±0.69	14.55^{a}±0.25
Day 30	12.84^{c}±0.08	13.67^{b}±0.13	13.98^{ab}±0.07	14.28^{a}±0.09	14.36^{a}±0.09
Day 40	11.56^{d}±0.15	13.15^{c}±0.14	13.39^{bc}±0.14	13.86^{ab}±0.06	13.95^{a}±0.05
Day 50	11.22^{c}±0.05	12.82^{b}±0.13	13.04^{ab}±0.17	13.29^{ab}±0.13	13.56^{a}±0.10
Day 60	11.12^{b}±0.14	12.32^{a}±0.21	12.56^{a}±0.06	12.78^{a}±0.09	12.82^{a}±0.16

*Values are Mean ± SE (n=3). Different letter superscripts in the same row show significant difference ($P < 0.05$).

At day 50 significantly ($P < 0.05$) highest and lowest ash contents were observed in T-4 (13.56% ± 0.10) and control (11.22% ± 0.05) respectively. Finally at 60 day no statistical

CHAPTER FIVE

DISCUSSION

5. Discussion

5.1 Proximate Composition

Proximate composition (protein, lipid, moisture and ash) of Nuna Tengra has been shown in Figure 5-8 and table 3-6 respectively.

5.1.1 Protein

The product which contains highest protein and fat content is referred as nutritious food. Dried fish (56.79%) hold more protein than the fresh fish (14.45%). In the current study the protein level for dried fish varied from 53.07 % to 58.97% depending on treatments. Changes of protein content with storage period were observed (Fig. 5). The protein content gradually decreased with increase of storage period for 60 days was observed 57.55% to 55.22%, 56.32% to 53.07%, 58.97% to 56.97%, 58.15% to 55.88% and 57.87% to 55.22% respectively in control, T-1, T-2, T-3 and T-4 (Table.3 and fig.5). However, no significant change ($P > 0.05$) in protein content for 60 days of storage was observed in T-2 where the other treatments showed statistical difference ($P < 0.05$; Appendix-V).

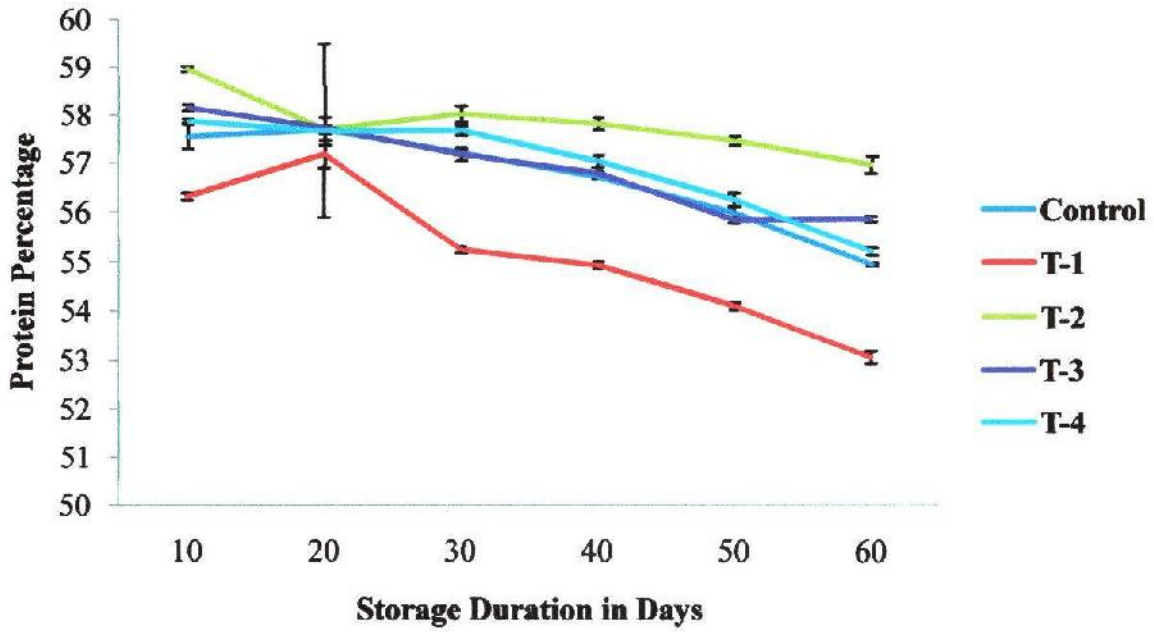


Figure 5: Protein content of Treated Tengra at different storage period

Lowest variation in protein content was observed in T-2 (58.97% to 56.97%) than the other treatments. Protein content of dried unsalted fish is lower than the salted fish in control and T-1 as protein is denatured by addition of excess amount of salt to the fish (Van-Klaveren and Legendre, 1965). In current study the highest protein content was observed in T-2 at a concentration 58.97% which was higher than salted and unsalted fish. Similar results were observed by Akhter *et al.,* (2013) on comparative study of the nutrient composition of the tengra fish (*Mystus vittatus*) cured by the salt and turmeric, and observed the highest protein (63.68%) for salt and turmeric than other treatments. This may happen because, turmeric powder contains slight amount of protein (8.5/100g) (Lal, 2012) which contribute to increase level of protein in T-2. Protein concentration decreased gradually in T-3 and T-4 with increasing turmeric powder as it contributes to gain more weight for the samples. The protein range found in this experiment ranges from 53.07% to 58.97% which was similar to Flowra *et al.,* (2012) and Akhter *et al.,* (2013). Normally sun-dried fishes contain 60 to 80% protein reported by Haque, (2004) which supported the current study.

5.1.2 Lipid

The below fig.6 depicts the lowering of lipid content with the storage period. There was significant difference ($P < 0.05$) in each treatment. Highest lipid content was observed in T-4 (12.25%) and lowest was observed in control (5.80%).

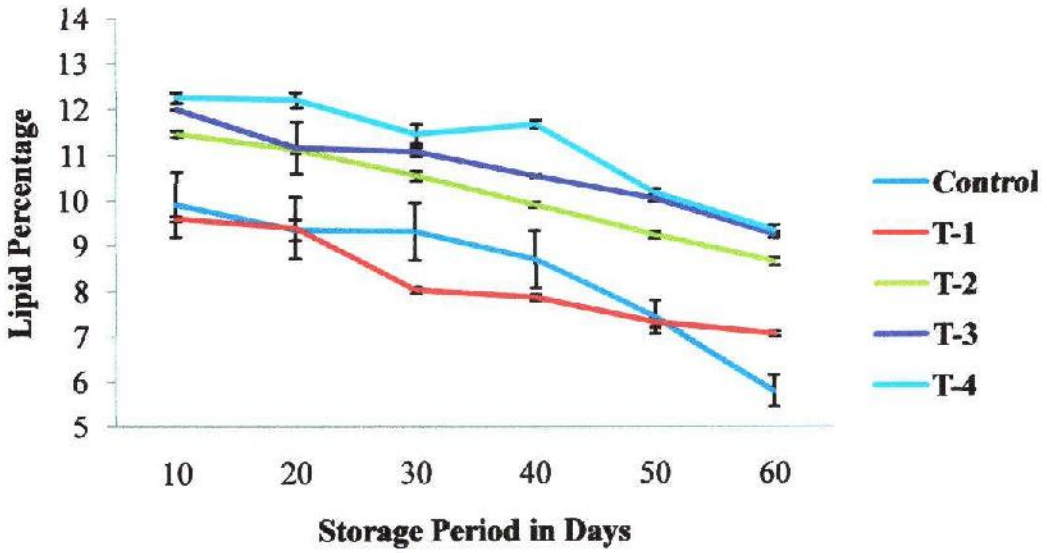


Figure 6: Lipid content of Treated Tengra at different storage period

Statistical difference ($P < 0.05$) at every 10 day intervals was observed in T-2 which was not observed in the other treatments (Appendix-V). The decrease of lipid content with storage period might be for lipid oxidation. Lipid content of salt and turmeric powder treated dried fishes is comparatively higher than the salted and unsalted fishes. The range of lipid content of the present study was 5.80% to 12.25% which supported the study conducted by Kalamani and Kamasastri, (1998), Flowra *et al.,* (2012) and Akhter *et al.,* (2013). Flowra *et al.,* (2012) observed the lipid content for *Mystus vittatus* 17.76% based on moisture content and 21.54% on dry matter. There was quite deviation for *M. gulio* and this might be for species, size, different body parts of the same fish, seasonal variation, temperature, oxidation of fat etc.

5.1.3 Moisture

Moisture content increased with the storage period in the each treatment has shown in Fig.7. There was significant difference ($P < 0.05$) for control, T-1, T-2, T-3 and T-4 respectively (Appendix-V). The highest moisture content was observed 22.15%, 20.10%, 16.25%, 18.22%, 21.32% and lowest was 17.75%, 16.68%, 12.56%, 3.22%, 15.20% in control, T-1, T-2, T-3 and T-4 respectively. The highest and lowest moisture content was calculated in control (22.15%) and T-2 (12.56%) respectively. Moisture content of unsalted dried Tengra was higher than the salted and turmeric treated fishes. Salt and 3% turmeric powder treated product T-2 (12.56%) contained the lowest moisture content than the other treatments which was similar to Akhter *et al.,* (2013).

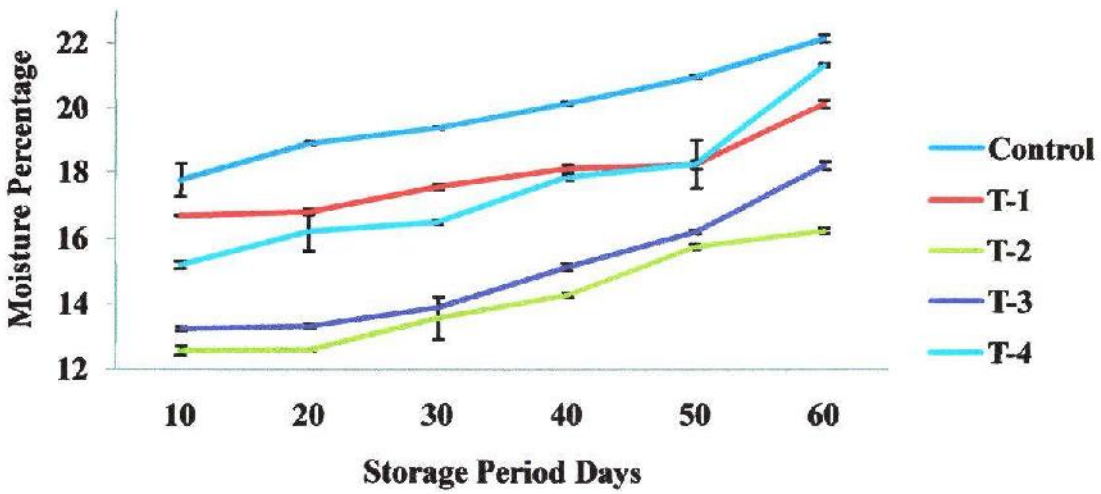


Figure 7: Moisture content of Treated Tengra at different storage period.

The lowest moisture content of the salt and turmeric treated products indicated that it was more resistant to the enzymatic and microbial activities and these qualities might lengthened their shelf life. According to BSTI (1982), the increased moisture content above 15% in dried fish influence the growth of mould and insect infestations which in turn would accelerate the spoilage of fish product. Moisture content of *M. gulio* might increase for temperature variation, humidity, weather etc. Moreover T-3 and T-4 contain more turmeric powder than the T-2 and this might be the reason for increasing the moisture content in T-3 and T-4. Haque, (2004) stated that normally the sun-dried fishes contain an average of 10% to 20% of moisture. Azam *et al.*, (2003) reported that the range of fourteen selected dried fishes and observed that moisture content ranged from 18.23% to 23.61%.

5.1.4 Ash

Ash contents increase slightly with the treatments and decrease with the storing period (Fig. 8). The lowest ash content was observed in control at 11.12% and increased to 15.23% in T-4. There was statistical difference ($P < 0.05$) in the each treatment (Appendix-V). Ash is the residue without water and volatile constituents containing carbondyoxide (CO_2), oxides of nitrogen. The deviation of ash changes increased more with the storage period and highest deviation was found in T-4 (12.82% to 15.23%). This might be the increase of moisture content, temperature change etc.

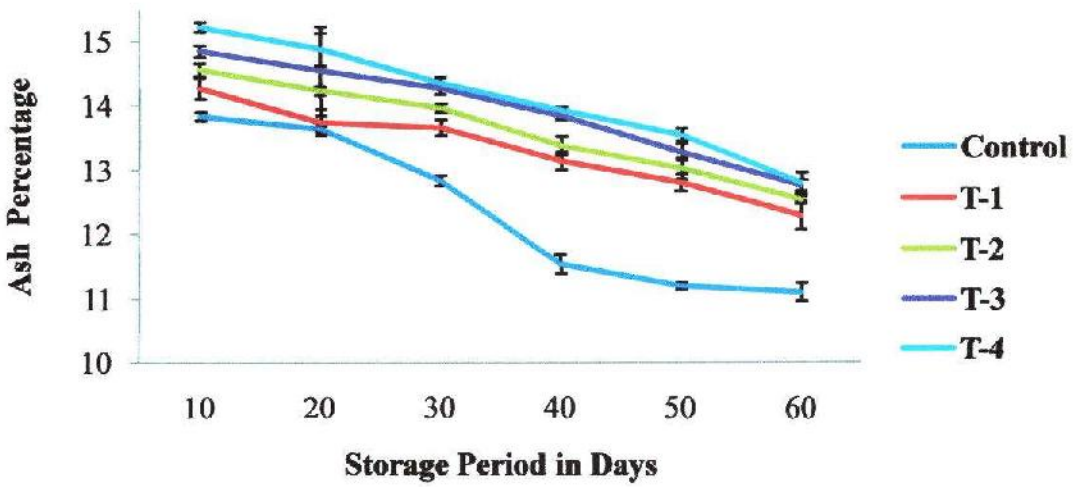


Figure 8: Ash content of Treated Tengra at different storage period.

The results of the present study supported Bhuiyan, (1992) who observed 6.6% to16.2% ash in dried fishes. The use of salt and turmeric powder might be the cause of increasing

of ash content with treatments control, T-1, T-2, T-3 and T-4 respectively. Flowra *et al.*, (2012) observed the variation of ash content among the studied dried fishes ranged within 9% to 30% on the basis of moisture and dry matter contents. Hussain *et al.*, (1992) stated that the ash content varied over a large range 1.4% to21.6% in 23 different dried species and also Azam *et al.*, (2003) observed 5.08% to 12.14% of ash content in fourteen dried fishes which supported the current experiment.

5.2 Microbial Activity

The Fig.9 depicts the Aerobic Plate Count of *M. gulio* at different five treatments. Microbial load was found in fresh condition at 8.63×10^5 CFU/g (Appendix-V). Microbial load decreased with the increase of the control, T-1, T-2, T-3 and T-4 respectively. No significant difference ($P > 0.05$) was in T-2, T-3 and T-4 (Appendix-V). The lowest microbial load was observed in T-4 at 1.78×10^3 CFU/g and highest was observed in control at 5.87×10^4 CFU/g. The APC at 60 day was comparatively higher than 30 day. Mixing observed salt and turmeric (an antimicrobial agent) together with fishes, they were much unfavorable for the microbes to grow.

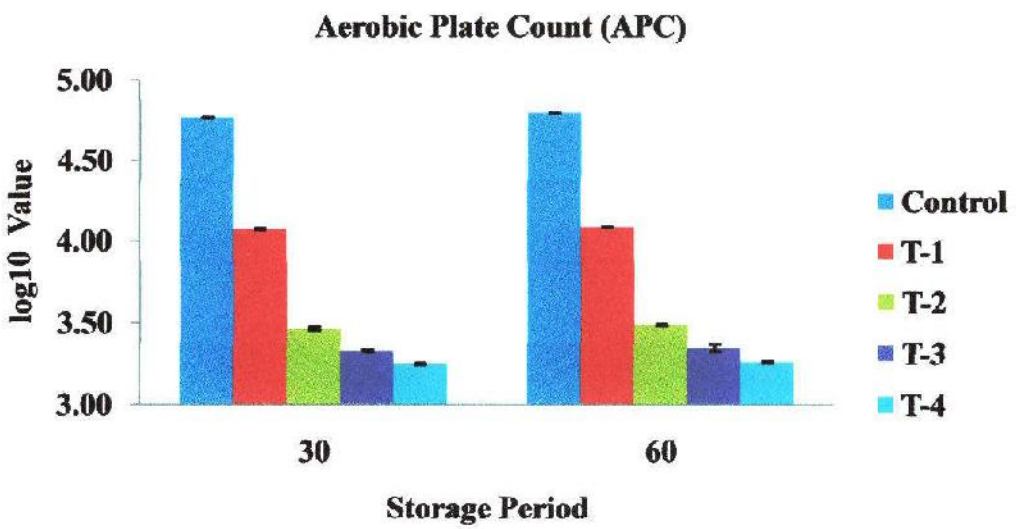


Figure 9: Microbial load of Nuna Tengra at different treatments.

Microbial load of the present experiment was in limit as ICMFS, (1974) mentioned SPC for microorganisms per gram weight for different fish sample to be 10^5CFU/g. Ali *et al.*, (2007) found Standard Plate count of seven dried fish samples like Loytta, Gang tengra and Phasa ranged from 4.23×10^3 to 7.8×10^3 CFU/g, five contained 3.2×10^4 to 6.07

$\times 10^4$ CFU/g, while the remaining two samples (Shaplapata and Churi) SPC were 2.26 and 2.77 CFU/g respectively which were in the range of the present study.

In present study it was observed that bacterial load was decreasing with salt and turmeric powder treatment. The lowest microbial activity was found in T-4. Salt is used as food preservation from ancient time because; it creates an unfavorable environment for most of the microorganism. As a result microbial activity of salted Tengra is lower than unsalted fishes. Turmeric powder also acts as an antimicrobial agent. So when salt and turmeric used together they were much unfavorable for the microbes to grow.

5.3 Organoleptic Aspects of Quality

The organoleptic scores of dried tengra were 6.62, 8.08, 8.83, 7.62 and 6.96 for control, T-1, T-2, T-3 and T-4 respectively (Appendix-II). The highest scores observed in T-2 where 3% salt and 2% turmeric powder was used. This might be the adequate proportion of salt and turmeric powder with the fish body weight. The composition of 3% and 4% turmeric with 3% salt might affect the texture, odor and skin appearance of dried tengra. The organoleptic score varied from 8.33 to 7.33 and 8.00 to 6.33 in T-3 and T-4 respectively which were moderately good. Skin appearance, odor and texture might be the reasons for increasing the quality from control to T-1. The organoleptic quality of T-3 (8.67 to 9.33) was much better than the other treatments. Obtaining result from current study was more or less similar to the results obtained from marine dried products of silver silver jew fish (*Johnius argentatus*), Bombay duck (*Harpodon nehereus*) and ribbon fish (*Trichiurus haumela*) which were stored for 90 days observed Ali *et al.*, (2007).

CHAPTER SIX

CONCLUSION

6. Conclusion

The experiment was conducted to determine the proximate composition, microbial load and organoleptic quality assessment of *Mystus gulio* that had been treated with 3% salt and turmeric of different levels followed by drying in solar-tent dryer prior to storage for a period of 60 days. After completing the study the following conclusion could be drawn:

1. With the increase in storage duration the nutrients viz. protein, lipid and ash content decrease but the moisture level gradually increases.
2. Microbial load of the fish substantially decreases when it is treated with salt and turmeric followed by sun drying. However, with the increase in storage period it again increases slightly.
3. Little amount of addition of turmeric and salted dry fish can maintain its texture, color, skin appearance and odor acceptable avoiding fragileness.

Recommendation:

Longer time storage of Nuna tengra, *Mystus gulio*, can be done by treating with 3% salt and 2% turmeric followed by sun drying in solar-tent dryer.

CHAPTER SEVEN

REFERENCES

7. References

Ahmed, M., Bhuiyan, A. D., Alam, A. M. S. and Huda, S. M. S., 1978. Radiation disinfestations studies on sun-dried fish. Indo-Pacific Fishery Commission, Proceedings 18th Session, Manila, Philippines 8-17 March, pp. 310-321.

Akter, T., Ahmed, A. T. A., Khaleque, M. A. and Begum, M., 2013. Effect of drying on quality of tengra (*Mystus vittatus*) treated with turmeric salt. *Unique Research J. of Bio. Sci.*, Vol. 1(1): 001-005.

Ali, M. Y., Asad, M. A., Rahi, M. L. and Hossain, M. M., 2007. Organoleptic microbiological assessment of ten commercially important dried fresh fishes. *South Asian J. Agric.*, Vol. 2 (1and2): 29-32.

Ananou, S., Maqueda, M., Martinez-Bueno, M. and Valdivia, E., 2007. Biopreservation, an ecological approach to improve the safety and shelf life of foods. Communicating current Research and Educational Topics and trends in Applied Microbiology. pp. 475-486.

AOAC (Association of Official Analytical Chemist). 1980. Official methods of Analysis (15th ed.). Inc., Suite, 400, Arlington, Virginia. Vol.2: 685-1298.

Azam, K., Basher, M. Z., Asaduzzaman, M., Hossain, M. H. and Ali, M. Y., 2003. Biochemical quality assessment of fourteen selected dried fish. *Univ. j. zool. Rajshahi Univ.* Vol. 22: 23-26.

Begum, M., Ahmed, A. T. A., Das, M. and Parveen, S., 2010. A comparative microbiological assessment of five types of selected fishes collected from two different markets. *J Advan Biol Res,* Vol. 4: 259-265.

Begum, M., Akter, T. and Minar, M. H., 2012. Effect of Salt Garlic on the Quality Microbial Content of Smoked Catfish (*Pangasianodon hypophthalmus*). *Int J Bioresour Stress Manage,* Vol. 3(4): 464-467.

BFRI (Bangladesh Fisheries Research Institute), 1998. Research progress report for 1996-1997. 73p.

Bhuiyan, A. S., Islam, M. A., Hossain, B. B. M. and Absar, N., 1992. Biochemical composition and nutritional value of Cirrhina reba (Hamilton-1822) of Bangladesh. *J.Bio-Sci.* Vol. 11: 127-130.

Bhuiyan, M. R., 1992. Proximate Biochemical Analysis and Spoilage Patter of Six Marine Fishes of the Bay of Bengal. Master Thesis, Institute of Marine Science and Fisheries, University of Chittagong, Chittagong.

BSTI (Bangladesh Standard Testing Institute), 1982. Dried, dehydrated and unsalted fish products. Vol. 156: 3-6.

Chinivasagm, H. N. and Vidanapthirama, G. S., 1982. Quality change bacterial flora associated with French Sardine (*Amblygaster sirm*) under deleted icing condition. FAO Fish Rep, Vol. 317: 01-10.

Christofer, F. M., 1978. Micro flora of pond reared shrimp (*Penaeus stylirostris, Penaeus vennamei Penaeus setiferus*). *J. Fd. Prot*, Vol. 41: 20-23.

Conne, J. J., 1995. Control of fish quality. Fishing news book, a division of black ell science Ltd., Vol. 1: 4th edn.

Coulter, J. P. and Disney, J. G., 1987. The hling, processing marketing of fish in Bangladesh. Overseas Development Natural Resources Institute (ODNRI), Bulletin No. 1.

Cutting, C. L., 1962. The influence of drying, salting smoking on the nutritive value of fish. In: Fish in Nutrition, Ed. by Heen, E. Kreuzer, R. Fishing News (books) Ltd., London.

Doe, P. E., Ahmed, M., Muslemuddin, M. and Sachithananthan, K., 1977. A polythene tent drier for improved sun drying of fish. *Food Technology in Australia*, Vol. 29: 437-441.

Eigner, D. and Scholz, D., 1999. Ferula asafoetida Curcuma longa in traditional medical treatment diet in Nepal. *J Ethnopharmacology,* Vol. 67: 01-06.

Eyo, A. A., 1986. Significance of fish hling preservation processing in the development of Nigeria inl fisheries with special reference to Kanji Lake. Fisheries society Nigeria: 3rd annual conference proceedings.

Farber, L., 1965. Freshness test in fish as food. George Borgstrom (Editor). Academic Press, New York, Vol. 4: 65-126.

Farid, F. B., Latifa, G. A., Nahid, M. N. and Begum, M., 2014. Protective Effect of Brine-Salt Curing On Physico-Chemical Attributes on The Taki Fish (*Channa punctatus*) and The Tengra Fish (*Mystus tengra*) at Room Temperature. *Bangladesh J. Zool.* Vol. 42(2): 271-276.

Flowra, F. A., Nahar, D. G., Tumpa, A. S. and Islam, M. T., 2012. Biochemical analysis of Five Dried Fish species of Bangladesh. *Univ. j. zool. Rajshahi Univ.*, Vol. 31: 09-11.

Haque, E., 2004. Bangladesher Chhoto Machh (A book on small fishes of Bangladesh). Published by Graphic Sign, Mymensingh,Vol. 2200: 81-84.

Hardy, R. and Smith, J. G. M., 1976. The storage of Mackerel (*Scomber scoutbrus*). Development of histamine rancidity. *Journal of Science of Food Agriculture*, Vol. 27: 595-599.

Abdul Hei, A and Ch Sarojnalini, 2012.Study of Protein Quality of Some Fresh And Smoke-Dried Hill Stream Fishes From Manipur, India. *N. Y. Sci. J.,* Vol. 5(11):1-6.

Horowitz, W., 1984. Methods of Analysis of the Association of Official Analytical Chemists. Association of Official Analytical Chemists, Washington, DC., pp: 1089-1106.

Hossain, M. M., Karim, A., Alam, Z., Islam, M. M. S., Khan, A. and Hossain, A., 2012. Effect of pre-treatment on the drying of Ghonia fish Labeo ghonius in the open sun and in a tent. *Bangladesh J. Zool.* Vol. 20: 231-238.

Huang, H. C., Jan, T. R. and Yeh, S. F., 1992. Inhibitory effect of curcumin, an anti-inflammatory agent, on vascular smooth muscle cell proliferation. *Eur. J. Pharmacol,* Vol. 221(2-3): 381-384.

Hussain, M. S. and Chrasekhara, N., 1994. Biliary proteins from hepatic bile of rats fed curcumin or capsaicin inhibit cholesterol crystal nucleation in supersaturated model bile. *Ind. J. Biochem. Biophy*, Vol. 31(5): 407-412.

ICMSF, 1974. Microorganisms in Food. Sampling for Microbiological analysis: Principles and specific analysis. Toronto International Commission on Microbiological Specifications for food. Vol. 2: 213.

Islam, M. A., Hossain, B. B. M., Bhuiyan, A. S. and Absar, N., 2003. Biochemical composition and nutritional value of Cirrhina reba (Hamilton-1822) of Bangladesh. *J.Bio-Sci.* Vol. 11: 127- 130.

Kalaimani, N. and Kamasstri, P. V., 1998. Quality characteristics of cured fish of commerce. *J. Fish. Technol*, Vol. 25: 54-57.

Kamruzzaman, A. K. M., 1992. Qualitative evaluation of some commercially dried fish products of Bangladesh. M.S. Thesis, Department of Fisheries Technology, Bangladesh Agricultural University, Mymensingh, Bangladesh. 37p.

Khan, M. A. A., 1992. Study on dry fish (marine) with special reference to insect infestation, use of health hazard insecticides and control effect of pirimiphos methyl. M.Sc. Thesis, Institute of Marine Sciences, University of Chittagong.

Lal J., 2012. Turmeric, Curcumin Our Life: A Review, Bull. Environ. Pharmacol. Life Sci.; Vol. 1(7): 11–17.

Latifa, G. A, Nahid, M. N, Farid, F. B. and Begum, M., 2014. Biochemical (proximate chemical) composition sensory evaluation during storage at refrigeration temperature (4°C). *Res. J. Animal, Veterinary Fishery Sci,* Vol. 2(10): 10-15.

Laureti, E., 1998. Fish fishery products: World Apparent Consumption Statistics Based on Food Balance Sheets (1961-1993). FAO Fisheries Circular, No. 821, Revision 3, Rome.

Lim, G. P., Chu, T., Yang, F., Beech, W., Frautschy, S. A. and Cole, G. M., 2001. The curry spice curcumin reduces oxidative damage amyloid pathology in an Alzheimer transgenic mouse. *J. Neurosci*, Vol. 21(21): 8370-8377.

Mansur, M. A., Gheyasuddin, S. and Bhuiya, A. K. M. A., 1989. Preparation of anew ready to use dried semi fermented fish product of increased shelf life from *Puntius sp. Bangladesh Journal of Fisheries,* Vol. 13: 33-39.

Mazumder, M. S. A., Rahman, M. M., Ahmed, A. T. A., Begum, M. and Hossain, M. A. 2008. Proximate composition of some indigenous fish species in Bangladesh. *Int. J. Sustain Crop Prod.* Vol. 3(4): 18-23.

Mehbub, M. F., 2004. Community participatory research of the production of high quality marine dried fish products by a low cost solar tunnel drier. MS Thesis submitted to the Department of Fisheries Technology, Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh, Bangladesh. 169p.

Minar, M. H., Mahfuj, M. S. and Hossain, M. B., 2012. Biochemical Composition of an Endangered Fish, Labeobata (Hamilton, 1822) from Bangladesh Waters. *American Journal of Food Technology,* Vol. 7: 633-641.

Mollah, A. H., Rahman, M. S. and Alam, M. T., 1998. Study of proximate chemical analysis of Bangladeshi freshwater fish Rita rita (Ham.) and seasonal variation of lipid, protein and related substances. *Univ.j. zool. Rajshahi Univ.* Vol. 17: 01- 06.

Nakamura, K., Yasunaga, Y., Segawa, T., Ko, D., Moul, J. W., Srivastava, S. and Rhim, J. S., 2002. Curcumin down-regulates AR gene expression in prostate cancer cell lines. *Int. J. Oncol,* Vol. 21: 825-830.

Neuschler, E. and Freund, D.A., 1988. An Overview of Medicaid Capitation and Case Management Initiatives. Health Care Financing Review 1986 Annual Supplement. pp. 21-30.

Nurullah, M., 2005. Quality assessment improvement of traditionally dried small indigenous fish of Bangladesh. *Ph.D.* Thesis. Department of Fisheries

Technology, Bangladesh Agricultural University, Mymensingh, Bangladesh. 184p.

Nurullah, M., Saha, S. C., Kamal, M. and Wahab, M. A., 2002. Nutritional values of traditional dried products of freshwater small indigenous fish species of Bangladesh. Bull. Fac. Edu., Ibaraki Univ (Nat. Sci). pp. 75-86.

Pearson, D., 1976. Chemical Analysis of Foods. 7th Edn., Church Hill Livingstone, London, UK., pp: 72-73,138-143, 488-496.

Peirce, A., 1999. The American Pharmaceutical Association. Practical guide to natural medicines. The Stone Song Press, New York.

Prathapan, A., Lukhman, M., Arumughan, C., Sundaresan, A. and Raghu, K. G., 2009. Effect of heat treatment on curcuminoid, color value total polyphenols of fresh turmeric rhizome. *Int J Food Sci Tech,* Vol. 44: 1438-1444.

Qudrat-I-Khuda M., De. H. N., Khan N. H. and Debnath J. C., 1962. Biochemical and nutritional studies on Pakistan Fish. Part 7. Chemical Composition and Quality of the Traditionally Processed Fish. Pak. J. pp. 71-72.

Reza, M. S., Bapary, M. A. J., Ahasan, C. T., Islam, M. N. and Kamal, M., 2009: Shelf life of several marine fish species of Bangladesh during ice storage. *International Journal of Food Science Technology,* Vol. 44: 1485–1494.

Reza, M. S., Bapary, M. A. J., Islam, M. N. and Kamal. M., 2008. Optimization of marine fish drying using solar tunnel dryer. Journal of Food Processing And Preservation. Vol. 33: 47-59.

Rubbi, S. F., Muzibar, M., Khan, A.R., Jahan, S. S. and Majeda, B., 1987. Proximate composition and quality of some commercial species of fresh water fishes. *Bangladesh J. Sci. Res*, Vol. 5(1): 1-20.

Sachithananthan, K., Trim, D. M. and Spears, C. I., 1985. A solar- dome dryer for drying fish. Proceedings of the FAO expert consultants of fish technology, In Africa Lusaka Zambia, Vol. 329: 161-172.

Saha, D., 2003. Conserving fish biodiversity in the Sundarbans vallages of India. Produced by CIP-UPWARD, in partnership with GTZ Gmblt, IDRC of Canada, IPGRI SEARICE. pp. 439-441.

Shah, B. H., Nawaz, Z., Pertani, S. A., Roomi, A., Mahmood, H., Saeed, S. A. and Gilani, A. H., 1999. Inhibitory effect of curcumin, a food spice from turmeric, on platelet-activating factor arachidonic acid-mediated platelet aggregation through inhibition

of thromboxane formation Ca^{2+} signaling. Biochem. Pharmacol, Vol. 58(7): 1167-1172.

Shewan, J. M. and Ehrenberg, R. T., 1977. The Bacteriology of Fresh Spoilage; The Biochemical changes Induced by Bacterial Action. In Hling, Processing Marketing of Tropical Fish. Tropical Products Institute, London. pp. 51-66.

Sidhu, G. S., Singh, A. K., Thaloor, D., Banaudha, K. K., Patnaik, G. K. and Srimal, R. C., 1998. Enhancement of wound healing by curcumin in animals. Wound Repair Regen, Vol. 6: 167-177.

Stansby, M. E., 1962. Proximate composition of fishes. In: Fish in Nutrition, Ed. By E. Heen and R. Kreuzer. Fishing News (Books) Ltd., Ludgate House, 110 Fleet Street, London, E.C. Engl. 55p.

Sulieman, A. M. E., Hassan, Z. M. A. and Elkhalifa, E. A., 2014. Microbial Safety of Dried Fish Meat (Ke- jeik) produced in Sudan. *Food Nutrition Sciences,* Vol. 5: 606-613.

Sultana, N. and Hossain, M. T. 2010. Microbial quality of dried fish of different areas Chittagong and Mymensingh districts of Bangladesh. *International Journal of Bioresearch,* Vol. 2 01-05.

Thresiamma, K. C., George, J., and Kuttan, R., 1996. Protective effect of curcumin, ellagic acid bixin on radiation induced toxicity. *Indian J. Exp. Biol,* Vol. 34(9): 845-847.

Van-Klaveren, F. W. and Legendre, R., 1965 Salted cod. Fish as Food Borgstrom, G. ed. Vol. III. New York: Academic Press.

Viswanathan, P. G. N. and Mathew, S., 2000. Biochemical composition of fish and shellfish.Central Institute of Fisheries Technology, Cochin. CIFT Technology Advisory Series. pp. 04-07.

Whittle, K. J., 1997. Opportunities for improving the quality of fisheries products. In: uten JB, Borrosen T, Oehlenschlager J (Eds), Seafood from producer to consumer, integrated approach to quality. Proceedings of the International Seafood Conference on the 25th anniversary of WEFTA, Netherls, 13-16th November 1995, *Elsevier, Amsterdam,* pp. 549-560.

Wood, C. D., 1981. The prevention of losses in cured fish. FAO Fish. Tech. Paper, Vol. 219: 87.

http://www.slideshare.net/sarah_jumali/serial-dilution, 15 Nov, 2015, 8.30 pm

CHAPTER EIGHT

Appendix

Appendix

Appendix-1

Proximate Composition (Raw Data)

Protein (Results are in Triplicates)

Days	Control	3% Salt Only (T-1)	3% Salt+2% Turmeric (T-2)	3% Salt+3% Turmeric (T-3)	3% Salt+4% Turmeric (T-4)
10	57.29	56.46	59.01	58.24	57.95
10	58.05	56.22	58.87	58.02	57.82
10	57.31	56.28	59.03	58.19	57.84
20	57.56	57.75	54.31	57.68	57.45
20	57.83	56.99	60.37	57.82	57.31
20	57.68	56.81	58.43	57.7	58.23
30	57.3	55.15	58.09	56.91	57.87
30	57.18	55.37	57.68	57.28	57.55
30	57.15	55.23	58.26	57.35	57.59
40	56.78	54.89	58	56.8	56.84
40	56.65	55.07	57.56	56.88	57.27
40	56.74	54.83	57.88	56.73	57.01
50	56.19	53.98	57.59	55.75	56.34
50	56.03	54.16	57.27	55.92	55.99
50	55.77	54.19	57.52	55.88	56.45
60	54.88	53.31	57.17	55.81	55.13
60	54.98	53.01	56.62	55.85	55.38
60	54.99	52.89	57.12	55.98	55.15

Lipid (Results are in Triplicates)

Days	Control	3% Salt Only (T-1)	3% Salt+2% Turmeric (T-2)	3% Salt+3% Turmeric (T-3)	3% Salt+4% Turmeric (T-4)
10	11.35	9.65	11.37	11.98	12.02
10	9.37	9.5	11.61	11.98	12.4
10	9.04	9.68	11.43	12.01	12.33
20	9.83	10.13	11.07	10.04	12.27
20	9.11	10.03	11.04	11.78	12.45
20	9.15	8.03	11.25	11.66	11.88
30	10.56	7.99	10.44	11.21	11.87
30	8.92	8.15	10.45	10.89	11.23
30	8.47	7.92	10.76	11.11	11.26
40	8.04	7.94	9.9	10.57	11.78
40	8.09	7.73	9.83	10.48	11.69
40	9.99	7.91	10.01	10.57	11.48
50	8.16	7.48	9.35	10.1	10.01
50	7.06	7.14	9.11	9.91	10.25
50	7.11	7.34	9.29	10.15	10.28
60	6.17	7.14	8.8	9.36	9.39
60	6.13	6.95	8.5	9.25	9.14
60	5.09	7.12	8.71	9.14	9.52

Moisture (Results are in Triplicates)

Days	Control	3% Salt Only (T-1)	3% Salt+2% Turmeric (T-2)	3% Salt+3% Turmeric (T-3)	3% Salt+4% Turmeric (T-4)
10	18.26	16.22	12.86	13.28	14.98
10	18.22	17.38	12.43	13.28	15.38
10	16.76	16.45	12.39	13.1	15.24
20	18.79	16.86	12.66	13.38	15.63
20	18.84	16.62	12.6	13.36	15.59
20	18.99	16.88	12.52	13.16	17.43
30	19.42	17.68	14.85	13.87	16.56
30	19.38	17.41	12.88	13.9	16.57
30	19.25	17.56	12.91	13.84	16.37
40	20.18	18.19	14.35	15.24	17.96
40	20.17	17.88	14.11	14.9	17.87
40	20.01	18.26	14.29	15.22	17.69
50	21.01	18.25	15.87	16.23	16.82
50	20.99	18.01	15.79	16.11	18.92
50	20.85	18.43	15.59	16.29	19.02
60	21.95	20.16	16.29	18.38	21.42
60	22.15	20.28	16.37	17.99	21.26
60	22.36	19.86	16.09	18.29	21.28

Ash (Results are in Triplicates)

Days	Control	3% Salt Only (T-1)	3% Salt+2% Turmeric (T-2)	3% Salt+3% Turmeric (T-3)	3% Salt+4% Turmeric (T-4)
10	13.73	14.23	14.4	14.98	15.24
10	13.84	14.57	14.55	14.68	15.37
10	13.95	14.02	14.73	14.88	15.09
20	13.58	13.93	14.26	16.59	14.08
20	13.75	13.98	14.34	14.55	14.61
20	13.62	13.35	14.12	14.51	14.95
30	12.71	13.89	13.91	14.43	14.22
30	12.83	13.45	13.91	14.12	14.53
30	12.99	13.68	14.11	14.28	14.33
40	11.51	13.39	13.59	13.98	14.05
40	11.33	13.15	13.11	13.83	13.88
40	11.85	12.91	13.47	13.78	13.91
50	11.26	12.98	12.84	13.51	13.56
50	11.29	12.92	12.91	13.07	13.73
50	11.12	12.56	13.38	13.29	13.39
60	11.37	12.71	12.52	12.95	13.14
60	11.13	12.28	12.49	12.66	12.6
60	10.87	11.97	12.67	12.73	12.72

Microbial Load (Results are in Triplicates)

Days	Control	3% Salt Only (T-1)	3% Salt+2% Turmeric (T-2)	3% Salt+3% Turmeric (T-3)	3% Salt+4% Turmeric (T-4)
30	58.41	11.96	2.995	2.19	1.81
30	58.49	11.655	2.98	2.12	1.77
30	59.2	11.935	2.785	2.11	1.76
60	62.775	12.205	3.12	2.34	1.801
60	62.915	12.213	3.008	2.335	1.818
60	62.71	12.242	3.112	2.015	1.85

Raw Fish (Results are in Triplicates)

Protein	Lipid	Moisture	Ash	TPC
14.47	6.43	76.41	4.29	862820
14.43	6.50	76.53	4.25	863500
14.45	6.36	76.47	4.21	862680

Appendix-II
Organoleptic Test

Panel Members

1. **Sudip Debnath,** Lecturer, Fisheries and Marine Resource Technology Discipline, Khulna University.
2. **Sheik Tareq Arafat,** Lecturer, Fisheries and Marine Resource Technology Discipline, Khulna University.
3. **Md. Shahin Parvez,** Lecturer, Fisheries and Marine Resource Technology Discipline, Khulna University.

Sudip Debnath

Skin Appearance					
Days	**Unsalted (T1)**	**Salted (T2)**	**2% Turmeric (T3)**	**3% Turmeric (T4)**	**4% Turmeric (T5)**
10 Days	8	9	10	9	9
30 Days	7	8	9	8	8
60 Days	6	7	8	8	7
Average	7.00	8.00	9.00	8.33	8.00
Texture					
Days	**Unsalted (T1)**	**Salted (T2)**	**2% Turmeric (T3)**	**3% Turmeric (T4)**	**4% Turmeric (T5)**
10 Days	9	9	10	8	7
30 Days	8	9	9	8	6
60 Days	6	8	8	7	6
Average	7.67	8.67	9.00	7.67	6.33
Color					
Days	**Unsalted (T1)**	**Salted (T2)**	**2% Turmeric (T3)**	**3% Turmeric (T4)**	**4% Turmeric (T5)**
10 Days	7	9	10	9	9
30 Days	7	8	9	8	8
60 Days	6	7	9	8	7
Average	6.67	8.00	9.33	8.33	8.00
Odor					
Days	**Unsalted (T1)**	**Salted (T2)**	**2% Turmeric (T3)**	**3% Turmeric (T4)**	**4% Turmeric (T5)**
10 Days	7	9	9	8	7
30 Days	6	8	9	7	7
60 Days	6	7	8	7	6
Average	6.33	8.00	8.67	7.33	6.67

Sheik Tareq Arafat

Skin Appearance					
Days	**Unsalted (T1)**	**Salted (T2)**	**2% Turmeric (T3)**	**3% Turmeric (T4)**	**4% Turmeric (T5)**
10 Days	9	9	10	10	10
30 Days	8	9	10	9	9
60 Days	7	9	10	9	8
Average	8.00	9.00	10.00	9.33	9.00
Texture					
Days	**Unsalted (T1)**	**Salted (T2)**	**2% Turmeric (T3)**	**3% Turmeric (T4)**	**4% Turmeric (T5)**
10 Days	8	8	9	7	6
30 Days	7	8	8	7	5
60 Days	5	7	7	6	5
Average	6.67	7.67	8.00	6.67	5.33
Color					
Days	**Unsalted (T1)**	**Salted (T2)**	**2% Turmeric (T3)**	**3% Turmeric (T4)**	**4% Turmeric (T5)**
10 Days	8	10	10	10	9
30 Days	8	9	10	9	9
60 Days	7	8	10	9	8
Average	7.67	9.00	10.00	9.33	8.67
Odor					
Days	**Unsalted (T1)**	**Salted (T2)**	**2% Turmeric (T3)**	**3% Turmeric (T4)**	**4% Turmeric (T5)**
10 Days	6	8	8	7	6
30 Days	5	7	8	6	6
60 Days	5	6	7	6	5
Average	5.33	7.00	7.67	6.33	5.67

Md. Shahin Parvez

Skin Appearencd					
Days	**Unsalted (T1)**	**Salted (T2)**	**2% Turmeric (T3)**	**3% Turmeric (T4)**	**4% Turmeric (T5)**
10 Days	7	8	9	8	9
30 Days	6	7	8	7	7
60 Days	5	6	7	7	6
Average	6.00	7.00	8.00	7.33	7.33
Texture					
Days	**Unsalted (T1)**	**Salted (T2)**	**2% Turmeric (T3)**	**3% Turmeric (T4)**	**4% Turmeric (T5)**
10 Days	9	10	10	9	8
30 Days	9	9	10	9	7
60 Days	7	9	10	8	7
Average	8.33	9.33	10.00	8.67	7.33
Color					
Days	**Unsalted (T1)**	**Salted (T2)**	**2% Turmeric (T3)**	**3% Turmeric (T4)**	**4% Turmeric (T5)**
10 Days	6	8	9	8	8
30 Days	6	7	8	7	7
60 Days	5	6	8	7	6
Average	5.67	7.00	8.33	7.33	7.00
Odor					
Days	**Unsalted (T1)**	**Salted (T2)**	**2% Turmeric (T3)**	**3% Turmeric (T4)**	**4% Turmeric (T5)**
10 Days	8	10	10	9	8
30 Days	7	9	10	8	8
60 Days	7	8	9	8	7
Average	7.33	9.00	9.67	8.33	7.67

Appendix-III
Descriptive

Protein

Descriptives							
		N	Mean	Std. Deviation	Std. Error	Minimum	Maximum
Day_10	Control	3	57.5500	.43313	.25007	57.29	58.05
	3% Salt Only	3	56.3200	.12490	.07211	56.22	56.46
	3% Salt + 2% Turmeric	3	58.9700	.08718	.05033	58.87	59.03
	3% Salt + 3% Turmeric	3	58.1500	.11533	.06658	58.02	58.24
	3% Salt + 4% Turmeric	3	57.8700	.07000	.04041	57.82	57.95
Day_20	Control	3	57.6900	.13528	.07810	57.56	57.83
	3% Salt Only	3	57.1833	.49893	.28806	56.81	57.75
	3% Salt + 2% Turmeric	3	57.7033	3.09466	1.78670	54.31	60.37
	3% Salt + 3% Turmeric	3	57.7333	.07572	.04372	57.68	57.82
	3% Salt + 4% Turmeric	3	57.6633	.49571	.28620	57.31	58.23
Day_30	Control	3	57.2100	.07937	.04583	57.15	57.30
	3% Salt Only	3	55.2500	.11136	.06429	55.15	55.37
	3% Salt + 2% Turmeric	3	58.0100	.29816	.17214	57.68	58.26
	3% Salt + 3% Turmeric	3	57.1800	.23643	.13650	56.91	57.35
	3% Salt + 4% Turmeric	3	57.6700	.17436	.10066	57.55	57.87
Day_40	Control	3	56.7233	.06658	.03844	56.65	56.78
	3% Salt Only	3	54.9300	.12490	.07211	54.83	55.07
	3% Salt + 2% Turmeric	3	57.8133	.22745	.13132	57.56	58.00
	3% Salt + 3% Turmeric	3	56.8033	.07506	.04333	56.73	56.88
	3% Salt + 4% Turmeric	3	57.0400	.21656	.12503	56.84	57.27
Day_50	Control	3	55.9967	.21197	.12238	55.77	56.19
	3% Salt Only	3	54.1100	.11358	.06557	53.98	54.19
	3% Salt + 2% Turmeric	3	57.4600	.16823	.09713	57.27	57.59
	3% Salt + 3% Turmeric	3	55.8500	.08888	.05132	55.75	55.92
	3% Salt + 4% Turmeric	3	56.2600	.24021	.13868	55.99	56.45
Day_60	Control	3	54.9500	.06083	.03512	54.88	54.99
	3% Salt Only	3	53.0700	.21633	.12490	52.89	53.31
	3% Salt + 2% Turmeric	3	56.9700	.30414	.17559	56.62	57.17
	3% Salt + 3% Turmeric	3	55.8800	.08888	.05132	55.81	55.98
	3% Salt + 4% Turmeric	3	55.2200	.13892	.08021	55.13	55.38

Lipid

Descriptives							
		N	Mean	Std. Deviation	Std. Error	Minimum	Maximum
Day_10	Control	3	9.9200	1.24936	.72132	9.04	11.35
	3% Salt Only	3	9.6100	.09644	.05568	9.50	9.68
	3% Salt + 2%Turmeric	3	11.4700	.12490	.07211	11.37	11.61
	3% Salt + 3%Turmeric	3	11.9900	.01732	.01000	11.98	12.01
	3% Salt + 4%Turmeric	3	12.2500	.20224	.11676	12.02	12.40
Day_20	Control	3	9.3633	.40464	.23362	9.11	9.83
	3% Salt Only	3	9.3967	1.18462	.68394	8.03	10.13
	3% Salt + 2%Turmeric	3	11.1200	.11358	.06557	11.04	11.25
	3% Salt + 3%Turmeric	3	11.1600	.97180	.56107	10.04	11.78
	3% Salt + 4%Turmeric	3	12.2000	.29138	.16823	11.88	12.45
Day_30	Control	3	9.3167	1.10002	.63509	8.47	10.56
	3% Salt Only	3	8.0200	.11790	.06807	7.92	8.15
	3% Salt + 2%Turmeric	3	10.5500	.18193	.10504	10.44	10.76
	3% Salt + 3%Turmeric	3	11.0700	.16371	.09452	10.89	11.21
	3% Salt + 4%Turmeric	3	11.4533	.36116	.20851	11.23	11.87
Day_40	Control	3	8.7067	1.11168	.64183	8.04	9.99
	3% Salt Only	3	7.8600	.11358	.06557	7.73	7.94
	3% Salt + 2%Turmeric	3	9.9133	.09074	.05239	9.83	10.01
	3% Salt + 3%Turmeric	3	10.5400	.05196	.03000	10.48	10.57
	3% Salt + 4%Turmeric	3	11.6500	.15395	.08888	11.48	11.78
Day_50	Control	3	7.4433	.62115	.35862	7.06	8.16
	3% Salt Only	3	7.3200	.17088	.09866	7.14	7.48
	3% Salt + 2%Turmeric	3	9.2500	.12490	.07211	9.11	9.35
	3% Salt + 3%Turmeric	3	10.0533	.12662	.07311	9.91	10.15
	3% Salt + 4%Turmeric	3	10.1800	.14799	.08544	10.01	10.28
	Total	15	8.8493	1.31004	.33825	7.06	10.28
Day_60	Control	3	5.7967	.61232	.35352	5.09	6.17
	3% Salt Only	3	7.0700	.10440	.06028	6.95	7.14
	3% Salt + 2%Turmeric	3	8.6700	.15395	.08888	8.50	8.80
	3% Salt + 3%Turmeric	3	9.2500	.11000	.06351	9.14	9.36
	3% Salt + 4%Turmeric	3	9.3500	.19313	.11150	9.14	9.52

Moisture

Descriptives							
		N	Mean	Std. Deviation	Std. Error	Minimum	Maximum
Day_10	Control	3	17.7467	.85471	.49347	16.76	18.26
	3% Salt Only	3	16.6833	.61419	.35460	16.22	17.38
	3% Salt + 2% Turmeric	3	12.5600	.26058	.15044	12.39	12.86
	3% Salt + 3% Turmeric	3	13.2200	.10392	.06000	13.10	13.28
	3% Salt + 4% Turmeric	3	15.2000	.20298	.11719	14.98	15.38
Day_20	Control	3	18.8733	.10408	.06009	18.79	18.99
	3% Salt Only	3	16.7867	.14468	.08353	16.62	16.88
	3% Salt + 2% Turmeric	3	12.5933	.07024	.04055	12.52	12.66
	3% Salt + 3% Turmeric	3	13.3000	.12166	.07024	13.16	13.38
	3% Salt + 4% Turmeric	3	16.2167	1.05097	.60678	15.59	17.43
Day_30	Control	3	19.3500	.08888	.05132	19.25	19.42
	3% Salt Only	3	17.5500	.13528	.07810	17.41	17.68
	3% Salt + 2% Turmeric	3	13.5467	1.12882	.65172	12.88	14.85
	3% Salt + 3% Turmeric	3	13.8700	.03000	.01732	13.84	13.90
	3% Salt + 4% Turmeric	3	16.5000	.11269	.06506	16.37	16.57
Day_40	Control	3	20.1200	.09539	.05508	20.01	20.18
	3% Salt Only	3	18.1100	.20224	.11676	17.88	18.26
	3% Salt + 2% Turmeric	3	14.2500	.12490	.07211	14.11	14.35
	3% Salt + 3% Turmeric	3	15.1200	.19079	.11015	14.90	15.24
	3% Salt + 4% Turmeric	3	17.8400	.13748	.07937	17.69	17.96
Day_50	Control	3	20.9500	.08718	.05033	20.85	21.01
	3% Salt Only	3	18.2300	.21071	.12166	18.01	18.43
	3% Salt + 2% Turmeric	3	15.7500	.14422	.08327	15.59	15.87
	3% Salt + 3% Turmeric	3	16.2100	.09165	.05292	16.11	16.29
	3% Salt + 4% Turmeric	3	18.2533	1.24231	.71725	16.82	19.02
Day_60	Control	3	22.1533	.20502	.11837	21.95	22.36
	3% Salt Only	3	20.1000	.21633	.12490	19.86	20.28
	3% Salt + 2% Turmeric	3	16.2500	.14422	.08327	16.09	16.37
	3% Salt + 3% Turmeric	3	18.2200	.20421	.11790	17.99	18.38
	3% Salt + 4% Turmeric	3	21.3200	.08718	.05033	21.26	21.42

Ash

Descriptives							
		N	Mean	Std. Deviation	Std. Error	Minimum	Maximum
Day_10	Control	3	13.8400	.11000	.06351	13.73	13.95
	3% Salt Only	3	14.2733	.27755	.16024	14.02	14.57
	3% Salt + 2% Turmeric	3	14.5600	.16523	.09539	14.40	14.73
	3% Salt + 3% Turmeric	3	14.8467	.15275	.08819	14.68	14.98
	3% Salt + 4% Turmeric	3	15.2333	.14012	.08090	15.09	15.37
Day_20	Control	3	13.6500	.08888	.05132	13.58	13.75
	3% Salt Only	3	13.7533	.35019	.20218	13.35	13.98
	3% Salt + 2% Turmeric	3	14.2400	.11136	.06429	14.12	14.34
	3% Salt + 3% Turmeric	3	15.2167	1.18951	.68676	14.51	16.59
	3% Salt + 4% Turmeric	3	14.5467	.43844	.25314	14.08	14.95
Day_30	Control	3	12.8433	.14048	.08110	12.71	12.99
	3% Salt Only	3	13.6733	.22008	.12706	13.45	13.89
	3% Salt + 2% Turmeric	3	13.9767	.11547	.06667	13.91	14.11
	3% Salt + 3% Turmeric	3	14.2767	.15503	.08950	14.12	14.43
	3% Salt + 4% Turmeric	3	14.3600	.15716	.09074	14.22	14.53
Day_40	Control	3	11.5633	.26407	.15246	11.33	11.85
	3% Salt Only	3	13.1500	.24000	.13856	12.91	13.39
	3% Salt + 2% Turmeric	3	13.3900	.24980	.14422	13.11	13.59
	3% Salt + 3% Turmeric	3	13.8633	.10408	.06009	13.78	13.98
	3% Salt + 4% Turmeric	3	13.9467	.09074	.05239	13.88	14.05
Day_50	Control	3	11.2233	.09074	.05239	11.12	11.29
	3% Salt Only	3	12.8200	.22716	.13115	12.56	12.98
	3% Salt + 2% Turmeric	3	13.0433	.29366	.16954	12.84	13.38
	3% Salt + 3% Turmeric	3	13.2900	.22000	.12702	13.07	13.51
	3% Salt + 4% Turmeric	3	13.5600	.17000	.09815	13.39	13.73
Day_60	Control	3	11.1233	.25007	.14438	10.87	11.37
	3% Salt Only	3	12.3200	.37162	.21455	11.97	12.71
	3% Salt + 2% Turmeric	3	12.5600	.09644	.05568	12.49	12.67
	3% Salt + 3% Turmeric	3	12.7800	.15133	.08737	12.66	12.95
	3% Salt + 4% Turmeric	3	12.8200	.28355	.16371	12.60	13.14

TPC

Descriptives							
		N	Mean	Std. Deviation	Std. Error	Minimum	Maximum
Day_30	Control	3	58.70000	.434856	.251064	58.410	59.200
	3% Salt Only	3	11.85000	.169337	.097767	11.655	11.960
	3% Salt + 2% Turmeric	3	2.92000	.117154	.067639	2.785	2.995
	3% Salt + 3% Turmeric	3	2.14000	.043589	.025166	2.110	2.190
	3% Salt + 4% Turmeric	3	1.78000	.026458	.015275	1.760	1.810
	Total	15	15.47800	22.700066	5.861132	1.760	59.200
Day_60	Control	3	62.80000	.104762	.060484	62.710	62.915
	3% Salt Only	3	12.22000	.019468	.011240	12.205	12.242
	3% Salt + 2% Turmeric	3	3.08000	.062482	.036074	3.008	3.120
	3% Salt + 3% Turmeric	3	2.23000	.186212	.107510	2.015	2.340
	3% Salt + 4% Turmeric	3	1.82300	.024880	.014364	1.801	1.850
	Total	15	16.43060	24.324422	6.280539	1.801	62.915

Appendix-IV

Homogeneity Test (Tukey HSD_a)

Protein (Result)

Day_10

Treatment	N	Subset for alpha = 0.05			
		1	2	3	4
3% Salt Only	3	56.3200			
Control	3		57.5500		
3% Salt + 4% Turmeric	3		57.8700	57.8700	
3% Salt + 3% Turmeric	3			58.1500	
3% Salt + 2% Turmeric	3				58.9700
Sig.		1.000	.408	.528	1.000

Day_20

Treatment	N	Subset for alpha = 0.05
		1
3% Salt Only	3	57.1833
3% Salt + 4% Turmeric	3	57.6633
Control	3	57.6900
3% Salt + 2% Turmeric	3	57.7033
3% Salt + 3% Turmeric	3	57.7333
Sig.		.988

Day_30

Treatment	N	Subset for alpha = 0.05		
		1	2	3
3% Salt Only	3	55.2500		
3% Salt + 3% Turmeric	3		57.1800	
Control	3		57.2100	
3% Salt + 4% Turmeric	3		57.6700	57.6700
3% Salt + 2% Turmeric	3			58.0100
Sig.		1.000	.073	.286

Day_40

Treatment	N	Subset for alpha = 0.05		
		1	2	3
3% Salt Only	3	54.9300		
Control	3		56.7233	
3% Salt + 3% Turmeric	3		56.8033	
3% Salt + 4% Turmeric	3		57.0400	
3% Salt + 2% Turmeric	3			57.8133
Sig.		1.000	.176	1.000

Day_50

Treatment	N	Subset for alpha = 0.05		
		1	2	3
3% Salt Only	3	54.1100		
3% Salt + 3% Turmeric	3		55.8500	
Control	3		55.9967	
3% Salt + 4% Turmeric	3		56.2600	
3% Salt + 2% Turmeric	3			57.4600
Sig.		1.000	.094	1.000

Day_60

Treatment	N	Subset for alpha = 0.05			
		1	2	3	4
3% Salt Only	3	53.0700			
Control	3		54.9500		
3% Salt + 4% Turmeric	3		55.2200		
3% Salt + 3% Turmeric	3			55.8800	
3% Salt + 2% Turmeric	3				56.9700
Sig.		1.000	.428	1.000	1.000

Lipid (Result)

Day_10

Treatment	N	Subset for alpha = 0.05	
		1	2
3% Salt Only	3	9.6100	
Control	3	9.9200	
3% Salt + 2%Turmeric	3		11.4700
3% Salt + 3%Turmeric	3		11.9900
3% Salt + 4%Turmeric	3		12.2500
Sig.		.960	.488

Day_20

Treatment	N	Subset for alpha = 0.05	
		1	2
Control	3	9.3633	
3% Salt Only	3	9.3967	
3% Salt + 2%Turmeric	3	11.1200	11.1200
3% Salt + 3%Turmeric	3	11.1600	11.1600
3% Salt + 4%Turmeric	3		12.2000
Sig.		.073	.409

Day_30

Treatment	N	Subset for alpha = 0.05		
		1	2	3
3% Salt Only	3	8.0200		
Control	3	9.3167	9.3167	
3% Salt + 2%Turmeric	3		10.5500	10.5500
3% Salt + 3%Turmeric	3			11.0700
3% Salt + 4%Turmeric	3			11.4533
Sig.		.080	.100	.299

Day_40

Treatment	N	Subset for alpha = 0.05			
		1	2	3	4
3% Salt Only	3	7.8600			
Control	3	8.7067	8.7067		
3% Salt + 2%Turmeric	3		9.9133	9.9133	
3% Salt + 3%Turmeric	3			10.5400	10.5400
3% Salt + 4%Turmeric	3				11.6500
Sig.		.312	.089	.576	.127

Day_50

Treatment	N	Subset for alpha = 0.05		
		1	2	3
3% Salt Only	3	7.3200		
Control	3	7.4433		
3% Salt + 2%Turmeric	3		9.2500	
3% Salt + 3%Turmeric	3		10.0533	10.0533
3% Salt + 4%Turmeric	3			10.1800
Sig.		.986	.056	.985

Day_60

Treatment	N	Subset for alpha = 0.05		
		1	2	3
Control	3	5.7967		
3% Salt Only	3		7.0700	
3% Salt + 2%Turmeric	3			8.6700
3% Salt + 3%Turmeric	3			9.2500
3% Salt + 4%Turmeric	3			9.3500
Sig.		1.000	1.000	.115

Moisture (Result)

Day_10

Treatment	N	Subset for alpha = 0.05		
		1	2	3
3% Salt + 2% Turmeric	3	12.5600		
3% Salt + 3% Turmeric	3	13.2200		
3% Salt + 4% Turmeric	3		15.2000	
3% Salt Only	3			16.6833
Control	3			17.7467
Sig.		.512	1.000	.138

Day_20

Treatment	N	Subset for alpha = 0.05		
		1	2	3
3% Salt + 2% Turmeric	3	12.5933		
3% Salt + 3% Turmeric	3	13.3000		
3% Salt + 4% Turmeric	3		16.2167	
3% Salt Only	3		16.7867	
Control	3			18.8733
Sig.		.424	.612	1.000

Day_30

Treatment	N	Subset for alpha = 0.05		
		1	2	3
3% Salt + 2% Turmeric	3	13.5467		
3% Salt + 3% Turmeric	3	13.8700		
3% Salt + 4% Turmeric	3		16.5000	
3% Salt Only	3		17.5500	
Control	3			19.3500
Sig.		.933	.164	1.000

Day_40

Treatment	N	Subset for alpha = 0.05			
		1	2	3	4
3% Salt + 2% Turmeric	3	14.2500			
3% Salt + 3% Turmeric	3		15.1200		
3% Salt + 4% Turmeric	3			17.8400	
3% Salt Only	3			18.1100	
Control	3				20.1200
Sig.		1.000	1.000	.281	1.000

Day_50

Treatment	N	Subset for alpha = 0.05		
		1	2	3
3% Salt + 2% Turmeric	3	15.7500		
3% Salt + 3% Turmeric	3	16.2100		
3% Salt Only	3		18.2300	
3% Salt + 4% Turmeric	3		18.2533	
Control	3			20.9500
Sig.		.855	1.000	1.000

Day_60

Treatment	N	Subset for alpha = 0.05				
		1	2	3	4	5
3% Salt + 2% Turmeric	3	16.2500				
3% Salt + 3% Turmeric	3		18.2200			
3% Salt Only	3			20.1000		
3% Salt + 4% Turmeric	3				21.3200	
Control	3					22.1533
Sig.		1.000	1.000	1.000	1.000	1.000

Ash (Result)

Day_10

Treatment	N	Subset for alpha = 0.05			
		1	2	3	4
Control	3	13.8400			
3% Salt Only	3	14.2733	14.2733		
3% Salt + 2% Turmeric	3		14.5600	14.5600	
3% Salt + 3% Turmeric	3			14.8467	14.8467
3% Salt + 4% Turmeric	3				15.2333
Sig.		.082	.346	.346	.133

Day_20

Treatment	N	Subset for alpha = 0.05
		1
Control	3	13.6500
3% Salt Only	3	13.7533
3% Salt + 2% Turmeric	3	14.2400
3% Salt + 4% Turmeric	3	14.5467
3% Salt + 3% Turmeric	3	15.2167
Sig.		.054

Day_30

Treatment	N	Subset for alpha = 0.05		
		1	2	3
Control	3	12.8433		
3% Salt Only	3		13.6733	
3% Salt + 2% Turmeric	3		13.9767	13.9767
3% Salt + 3% Turmeric	3			14.2767
3% Salt + 4% Turmeric	3			14.3600
Sig.		1.000	.221	.090

Day_40

Treatment	N	Subset for alpha = 0.05			
		1	2	3	4
Control	3	11.5633			
3% Salt Only	3		13.1500		
3% Salt + 2% Turmeric	3		13.3900	13.3900	
3% Salt + 3% Turmeric	3			13.8633	13.8633
3% Salt + 4% Turmeric	3				13.9467
Sig.		1.000	.619	.101	.986

Day_50

Treatment	N	Subset for alpha = 0.05		
		1	2	3
Control	3	11.2233		
3% Salt Only	3		12.8200	
3% Salt + 2% Turmeric	3		13.0433	13.0433
3% Salt + 3% Turmeric	3		13.2900	13.2900
3% Salt + 4% Turmeric	3			13.5600
Sig.		1.000	.119	.079

Day_60

Treatment	N	Subset for alpha = 0.05	
		1	2
Control	3	11.1233	
3% Salt Only	3		12.3200
3% Salt + 2% Turmeric	3		12.5600
3% Salt + 3% Turmeric	3		12.7800
3% Salt + 4% Turmeric	3		12.8200
Sig.		1.000	.180

Microbial Load (Result)

Day_30

Treatment	N	Subset for alpha = 0.05			
		1	2	3	4
3% Salt + 4% Turmeric	3	1.78000			
3% Salt + 3% Turmeric	3	2.14000			
3% Salt + 2% Turmeric	3		2.92000		
3% Salt Only	3			11.85000	
Control	3				58.70000
Sig.		.316	1.000	1.000	1.000

Day_60

Treatment	N	Subset for alpha = 0.05				
		1	2	3	4	5
3% Salt + 4% Turmeric	3	1.82300				
3% Salt + 3% Turmeric	3		2.23000			
3% Salt + 2% Turmeric	3			3.08000		
3% Salt Only	3				12.22000	
Control	3					62.80000
Sig.		1.000	1.000	1.000	1.000	1.000

Appendix-V
Homogeneity Test (Tukey HSD$_a$)
Protein (Discussion)

Control

Day	N	Subset for alpha = 0.05			
		1	2	3	4
60 Days	3	54.9500			
50 Days	3		55.9967		
40 Days	3			56.7233	
30 Days	3			57.2100	57.2100
10 Days	3				57.5500
20 Days	3				57.6900
Sig.		1.000	1.000	.118	.126

T-1

Day	N	Subset for alpha = 0.05				
		1	2	3	4	5
60 Days	3	53.0700				
50 Days	3		54.1100			
40 Days	3			54.9300		
30 Days	3			55.2500		
10 Days	3				56.3200	
20 Days	3					57.1833
Sig.		1.000	1.000	.603	1.000	1.000

T-2

Day	N	Subset for alpha = 0.05
		1
60 Days	3	56.9700
50 Days	3	57.4600
20 Days	3	57.7033
40 Days	3	57.8133
30 Days	3	58.0100
10 Days	3	58.9700
Sig.		.440

T-3

Day	N	Subset for alpha = 0.05				
		1	2	3	4	5
50 Days	3	55.8500				
60 Days	3	55.8800				
40 Days	3		56.8033			
30 Days	3			57.1800		
20 Days	3				57.7333	
10 Days	3					58.1500
Sig.		1.000	1.000	1.000	1.000	1.000

T-4

Day	N	Subset for alpha = 0.05			
		1	2	3	4
60 Days	3	55.2200			
50 Days	3		56.2600		
40 Days	3			57.0400	
20 Days	3			57.6633	57.6633
30 Days	3			57.6700	57.6700
10 Days	3				57.8700
Sig.		1.000	1.000	.095	.918

T_3

Day	N	Subset for alpha = 0.05		
		1	2	3
60 Days	3	9.2500		
50 Days	3	10.0533	10.0533	
40 Days	3		10.5400	
30 Days	3		11.0700	11.0700
20 Days	3		11.1600	11.1600
10 Days	3			11.9900
Sig.		.228	.054	.134

T_4

Tukey HSD[a]

Day	N	Subset for alpha = 0.05			
		1	2	3	4
60 Days	3	9.3500			
50 Days	3		10.1800		
30 Days	3			11.4533	
40 Days	3			11.6500	11.6500
20 Days	3				12.2000
10 Days	3				12.2500
Sig.		1.000	1.000	.905	.078

Moisture (Discussion)

Control

Day	N	Subset for alpha = 0.05				
		1	2	3	4	5
10 Days	3	17.7467				
20 Days	3		18.8733			
30 Days	3		19.3500	19.3500		
40 Days	3			20.1200	20.1200	
50 Days	3				20.9500	
60 Days	3					22.1533
Sig.		1.000	.619	.179	.131	1.000

T_1

Day	N	Subset for alpha = 0.05			
		1	2	3	4
10 Days	3	16.6833			
20 Days	3	16.7867	16.7867		
30 Days	3		17.5500	17.5500	
40 Days	3			18.1100	
50 Days	3			18.2300	
60 Days	3				20.1000
Sig.		.998	.078	.134	1.000

T_2

Day	N	Subset for alpha = 0.05		
		1	2	3
10 Days	3	12.5600		
20 Days	3	12.5933		
30 Days	3	13.5467	13.5467	
40 Days	3		14.2500	
50 Days	3			15.7500
60 Days	3			16.2500
Sig.		.199	.511	.797

T_3

Day	N	Subset for alpha = 0.05				
		1	2	3	4	5
10 Days	3	13.2200				
20 Days	3	13.3000				
30 Days	3		13.8700			
40 Days	3			15.1200		
50 Days	3				16.2100	
60 Days	3					18.2200
Sig.		.976	1.000	1.000	1.000	1.000

T_4

Day	N	Subset for alpha = 0.05			
		1	2	3	4
10 Days	3	15.2000			
20 Days	3	16.2167	16.2167		
30 Days	3	16.5000	16.5000	16.5000	
40 Days	3		17.8400	17.8400	
50 Days	3			18.2533	
60 Days	3				21.3200
Sig.		.243	.098	.067	1.000

Ash (Discussion)

Control

Day	N	Subset for alpha = 0.05		
		1	2	3
60 Days	3	11.1233		
50 Days	3	11.2233		
40 Days	3	11.5633		
30 Days	3		12.8433	
20 Days	3			13.6500
10 Days	3			13.8400
Sig.		.076	1.000	.758

T_1

Day	N	Subset for alpha = 0.05			
		1	2	3	4
60 Days	3	12.3200			
50 Days	3	12.8200	12.8200		
40 Days	3		13.1500	13.1500	
30 Days	3			13.6733	13.6733
20 Days	3			13.7533	13.7533
10 Days	3				14.2733
Sig.		.334	.723	.178	.182

T_2

Day	N	Subset for alpha = 0.05			
		1	2	3	4
60 Days	3	12.5600			
50 Days	3	13.0433	13.0433		
40 Days	3		13.3900		
30 Days	3			13.9767	
20 Days	3			14.2400	14.2400
10 Days	3				14.5600
Sig.		.070	.279	.545	.353

T_3

Day	N	Subset for alpha = 0.05		
		1	2	3
60 Days	3	12.7800		
50 Days	3	13.2900	13.2900	
40 Days	3	13.8633	13.8633	13.8633
30 Days	3		14.2767	14.2767
10 Days	3			14.8467
20 Days	3			15.2167
Sig.		.167	.236	.058

T_4

Day	N	Subset for alpha = 0.05			
		1	2	3	4
60 Days	3	12.8200			
50 Days	3		13.5600		
40 Days	3		13.9467	13.9467	
30 Days	3			14.3600	
20 Days	3			14.5467	
10 Days	3				15.2333
Sig.		1.000	.421	.087	1.000

Appendix-VI

Anova Test

Protein

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Control	Between Groups	16.558	5	3.312	74.905	.000
	Within Groups	.531	12	.044		
T_1	Between Groups	32.909	5	6.582	112.114	.000
	Within Groups	.704	12	.059		
T_2	Between Groups	6.673	5	1.335	.813	.562
	Within Groups	19.692	12	1.641		
T_3	Between Groups	13.443	5	2.689	167.403	.000
	Within Groups	.193	12	.016		
T_4	Between Groups	16.052	5	3.210	47.569	.000
	Within Groups	.810	12	.067		

Lipid

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Control	Between Groups	35.585	5	7.117	8.659	.001
	Within Groups	9.863	12	.822		
T_1	Between Groups	16.855	5	3.371	13.671	.000
	Within Groups	2.959	12	.247		
T_2	Between Groups	17.696	5	3.539	194.585	.000
	Within Groups	.218	12	.018		
T_3	Between Groups	13.667	5	2.733	16.363	.000
	Within Groups	2.005	12	.167		
T_4	Between Groups	20.489	5	4.098	72.500	.000
	Within Groups	.678	12	.057		

Moisture

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Control	Between Groups	36.644	5	7.329	54.422	.000
	Within Groups	1.616	12	.135		
T_1	Between Groups	23.504	5	4.701	51.416	.000
	Within Groups	1.097	12	.091		
T_2	Between Groups	36.885	5	7.377	31.519	.000
	Within Groups	2.809	12	.234		
T_3	Between Groups	57.545	5	11.509	611.095	.000
	Within Groups	.226	12	.019		
T_4	Between Groups	69.583	5	13.917	30.605	.000
	Within Groups	5.457	12	.455		

Ash

ANOVA

		Sum of Squares	*df*	*Mean Square*	*F*	*Sig.*
Control	Between Groups	22.629	5	4.526	150.664	.000
	Within Groups	.360	12	.030		
T_1	Between Groups	7.499	5	1.500	18.164	.000
	Within Groups	.991	12	.083		
T_2	Between Groups	8.712	5	1.742	49.552	.000
	Within Groups	.422	12	.035		
T_3	Between Groups	12.817	5	2.563	9.959	.001
	Within Groups	3.089	12	.257		
T_4	Between Groups	10.506	5	2.101	35.605	.000
	Within Groups	.708	12	.059		

Microbial Load (TPC)

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Control	Between Groups	25.215	1	25.215	252.055	.000
	Within Groups	.400	4	.100		
T_1	Between Groups	.205	1	.205	14.136	.020
	Within Groups	.058	4	.015		
T_2	Between Groups	.038	1	.038	4.356	.105
	Within Groups	.035	4	.009		
T_3	Between Groups	.012	1	.012	.664	.461
	Within Groups	.073	4	.018		
T_4	Between Groups	.003	1	.003	4.205	.110
	Within Groups	.003	4	.001		

Appendix-VII

Photo Gallery

Fig-1: Fish drying in the dryer

Fig-2 Fish Drying

Fig-3: Lipid Determination

Fig-4: Protein Determination