PREPARATION OF EXTRUDED READY-TO-EAT FRIED FISH PRODUCT (FISH CHAKLI)

Dissertation submitted in the partial fulfillment
Of the requirement for the award of the degree of

MASTER OF FISHERIES SCIENCE

In

FISHERIES RESOURCE MANAGEMENT

By

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(1997-99)

Under the guidance of

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....to my
beloved Aai
and
Loving Family.

केन्द्रीय मत्स्य शिक्षा संस्थान
(समतुल्य विश्वविद्यालय) भारतीय कृषि अनुसंधान परिषद
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Certificate

This is to be certified that the dissertation entitled **"Preparation of Extruded Ready-to-Eat Fried Fish Product" (Fish Chakli)** is a record of bonafide research work done by **Mr. Sutar Vijaykumar B.** is an original contribution under my guidance and supervision. Based on the quality of work embodied in the dissertation, we recommend its submission for the partial fulfillment of requirements for the degree of **Master of Fisheries Science** in **Fisheries Resource Management, (1997—99)** batch of Central Institute of Fisheries Education (ICAR), Mumbai—61.

No part of this dissertation has previously formed the basis for any publication or for the award of any other degree, diploma or similar title to the best of our knowledge and belief.

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DECLARATION

I do hereby declare that the present dissertation entitled **Preparation of Extruded Ready-To-Eat Fried Fish Product (Fish Chakli)** is a record of research work done by me under the guidance of **Dr. S. Basu**, Associate professor, Fish Processing Technology Division, Central Institute of Fisheries Education, Mumbai. The dissertation has not previously formed the basis of the award of any degree, diploma or other similar titles.

This is an original work done and is submitted towards the partial fulfillment of the award for degree of Master of Fisheries Science in Fisheries Resource Management, the Central Institute of Fisheries Education, Deemed University under ICAR for the year 1997-99.

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INTRODUCTION

Chapter-1

INTRODUCTION

The knowledge of occurrence of fish in India dates back to three millennium B.C.(Hora, 1956). Fish remains cutmarks indicative of their use as food, have been obtained from excavation at Mohenjodero and Harappa of the Indus valley civilization (2500 B.C – 1500 B.C). Some 20,000 species of fish are known to inhabit waterbodies of various description. More than a thousand species of fish occur in India.

1.1 Resources of Fish in India

India has a long coastline of 8085km, continental shelf area of 0.5 million sq. km and EEZ of 2.02 million sq. km (Shanbhag and Jayapalan et al., 1996). The present level of exploitation of the marine resources is about 60% of the estimated potential of EEZ. Of the total fish production of 4.7 million tonnes/year, 2.4 million tonnes come from marine resources. Of which 60-70% is from the West Coast and 25-35% from East Coast and about 5% from islands. Marine landings mainly consist of pelagic fishes (40-60%), demersal fishes (35-45%), crustaceans (15-20%) and molluscs (5-15%).

1.2 Fish Production of India

World fish production has been increased over the years and is currently estimated at (112)millon tonnes. The rank of India in the world in fish production is 6th and it has vast potential for fisheries development. The total fish production of 1996-97 is (5.140) million tonnes, out of which (2.857) million tonnes comes only from marine resources,(Fishery Statistics CIFT,1998). The marine catch has been significantly increasing over the years.

Fish enjoys a very special consideration and place in human civilization from times immemorial. Its food value, gastronomic, culinary and nutritional brings it to the fare; many species of fish rank in the category of "gourmet par excellence". Fish is a highly nutritious food and is one of the most valuable sources of high-grade protein available to man in this hungry world. Besides protein, fish also provides good amount of oil, vitamins and minerals.

The nutritive and medicinal value of fish has been recognized from time immemorial. Fresh fish flesh provides an excellent source of protein for human diet. This protein is relatively of high digestibility, biological and growth promoting value for human consumption. Nutritional studies have proved that fish protein rank in the same class of chicken protein and are superior to milk, beef protein and egg albumin. Fish protein contains all the ten essential amino acids in the desirable strength for human consumption.

Table 1: Fish production of India. (in lakh tonnes)

Year	Marine	Inland	Total
1950-51	5.34	2.18	7.52
1960-61	8.80	2.80	11.60
1970-71	10.86	6.70	17.56
1980-81	15.55	8.87	24.42
1981-82	14.45	9.99	24.44
1982-83	14.27	9.40	23.67
1983-84	15.19	9.87	25.06
1984-85	16.98	11.03	28.01
1985-86	17.16	11.60	28.76
1986-87	17.13	12.29	29.42
1987-88	16.58	13.01	29.59
1988-89	18.17	13.35	31.52
1989-90	22.75	14.02	36.77
1990-91	23.00	15.36	38.36
1991-92	24.47	17.10	41.57
1992-93	25.76	17.89	43.65
1993-94	26.49	19.95	46.44
1994-95	26.92	20.97	47.89
1995-96	27.07	22.42	49.49
1996-97	28.57	22.83	51.40

Source:Handbook of fisheries statistics, Govt.of India.

1.3 Per Capita Consumption of Fish

In India, about 56% of population consume fish. The per capita consumption of fish in India is only 3.7 Kg, which is very low in comparison to Iceland, Faeroels, Japan, Portugal, Seychelles, Norway, Spain, Maldives and Bangladesh.

Table 2: Per Capita Consumption of Fish: (Per annum in the year 1992, Anon, 1996).

Region and Countries	Estimated weight(kg)
Iceland	92.1
Faeroels	85.1
Japan	72.1
Portugal	60.2
Seychelles	57.7
Norway	41.1
Spain	38.0
Maldives	33.0
Bangladesh	7.3
India	3.7

Source: fisheries statistics, Govt. of India, 1996.

1.4 Fish Protein

Amongst the numerous nutrition problems that exist in developing countries, the most serious is the protein malnutrition. In a country like India where the staple food of the majority of the population consists of cereals, for proper nutrition adequate

consumption of high quality protein is essential. Milk, egg and meat contain high quality of animal protein. But they are relatively more expensive and possibly beyond the reach of the average men. They're a need therefore for a suitable inexpensive animal protein of high quality, which could be easily incorporated in the diet of the people.

1.5 Demand and Potentiality of Fish in India

By the turn of this century, the increased population in India (1.12 billion expected) would need about 130 million tonnes of fish per year. The growing demand for animal protein during the period to the growth to world population and the economy of the developed countries make the necessity steady supply of food more and more imperative. According to the data published by Govt. of India, the total potential in the marine sector is 3.9 million tonnes and it is 4.5 million tonnes in inland sector. So, total potential of fish products in India is 8.4million tonnes. In 1995-96 the fish production is only 4.95 million tonnes. There is wide gap between the potential and actual production. So there will be need to increase production; Proper processing and preservation methods should be adopted to minimize wastage and develop value-added products, so that they can be properly distributed throughout the country. Thus through increased production and improved processing and distribution, per capita consumption of fish may be increased.

1.6 Biochemical Composition of Raw Fish

In biochemical composition, the important constituents of the fish muscle in their order of magnitude are moisture, protein, fats, non-protein nitrogenous compound of fish body (Govindan, 1985).

1.6.1 Moisture

Moisture content in Indian fishes generally varies between 70-80% though occasionally figures as high as 90% are also encountered, e.g. in Bombay duck. In fatty fishes, moisture content decreases with increasing fat content, the two together accounting approximately 80%.

1.6.2 Protein

Fish contains about 16-18% of protein (Srivastava, C.B.L., 1996). Protein occurs in fish in the form of (I) All intracellular components of muscle fiber as—myosin, myogen, myoalbumin and globulin. (ii) Collagen and connective tissue fibers, and (iii) Phosphoprotein and nucleoprotein. The connective tissue amounts to only 3-5%, thus rendering the fish protein more digestible than meat. About 90-95% of fish protein is assimilated by human subject. The digestibility co-efficient and biological value of the protein varies from species to species. Pelagic species, have high amino acid concentrations, particularly that of histidine which largely responsible for the flavor of their flesh.

1.6.3 Fat

Generally, 0.1 -22% fat is present in fish, mainly in muscle, head, tissues, roe, milt, liver, skeletal tissue, subcutaneous connective tissue and viscera. Liver in fish is often the main site with large deposits. However, brian shows the highest concentration of fat, and the heart the lowest. Liver and kidney ranks intermediate.

Depending upon the fat content, the fish may be classified as oily or fatty (fat content more than 8%), average fatty (fat content between (1 – 8%) and lean (fat content less than 1%). Major lipids in fish are triglycerides of fatty acids. Fish oil, particularly from marine origin contains high amount of unsaturated fatty acids, which are good for health, reducing cholesterol level in blood. Recently research has found that fish oil contains Highly Unsaturated Fatty Acids (HUFA) like DHA and EPA which gives support against cardio vascular diseases. They reduce blood pressure and reduce arteriosclerosis. They offer potential benefit in various inflammatory diseases. They help in normal visual development of children (Piggot and Jucker, 1990).

1.6.4 Minerals

These constitute 1- 2%of fish flesh composition. The bulk is concentrated in fish bones. Some elements like boron, fluorine, bromine, lithium and strontium are present in greater concentration in marine fish than in freshwater fish. Mercury is present in fish in greater concentration that it is in outside water.

The principle minerals are Ca, Mg, K, Na, P, Fe, S, Cl, Cu, Mn, I, Br, besides traces of Sr, Zn, Ba, Al, Pb, Mo, Co, Ni, Hg, Cd are also present.

1.6.5 Vitamins

Fish provides vitamins A, B and D-all essential vitamins for human diet. Vitamins are organic compounds which are regulatory in nature. Vitamins are grouped into two categories according to their solubility. B complex and C present in the muscle are water soluble while A, D, E, K are fat soluble.

1.6.6 Carbohydrates

Fish do not contains significant amount of carbohydrate, but certain fish store some of their energy reserve as glycogen which contributes to the characteristic sweet taste to the fish muscle.

1.6.7 Non-protein nitrogen compounds

Non-protein nitrogen compounds play a very important role in a physiological functions of live fish muscle (Govindan, 1985). These are generally encountered in fish muscle and are coprised of ammonia, trimethylammonium bases, guanidine and imidazole derivative and miscellaneous substances like urea, amino acids, purines and pyrimidines. These are of importance in preservation and processing of fish in so far as they influence their potential keeping qualities and contribute to their flavor.

1.7 Product Development

Product development has become a matter of increasing concern to the fisheries processing industry for a number of reasons. A principle one for fishery products companies in the Western world is the need to meet intense competition, to mentain and, if posible expand their position in the market. This reason is allied to the need to meet the changing tastes and demand of consumers. Another reasion is to make the fullest use of all available raw material and, yet again, to develop products from fish which are unfamiliar or new to the consumer. These reasions apply in varying degrees throughout the world wherever fishery products are distributed and wherever it is hoped to estabilish market for them. And as the food habits and the taste demands of people are very deeply ingrained and as these tastes and linkings differ from country to country, product development in harmony with them is essential for establishing any fishery processing industry.

In product development is first of all, to handle the food using any preservation and processing methods in such a way that its keeping quality is prolonged and so that it can be transported to places, where there is a demand for it and where it can become a good nutritious food.

In the advanced countries, the industry is keen on new product development research and hence incurs expenditure on such efforts. Such a situation has generated ideas as to how to increase the chances of making new products reach the

consumer. Most of product development research in marine fish processing in India is based on an in adequately utilized, cheap or seasonal glut of raw material resource. Known or new techniques of processing are applied to such raw materials and the result is proposed as a new product.

1.8 Factors Affecting New Product Development

New products proposal can be complete when they take into consideration all aspects of raw materials resources And processing costs, total annual out turn, scale of operation and profitability, consumers response to marketing and all related factors. Any new product worked out in the laboratory has little chance of being a worth while proposition not withstanding the merits of its scientific contribution when the processing technology, or the novelty of the product or excellence of the nutritive value of the product are isolated from these factors.

1.8.1 Raw materials

Cheapness or abundance of raw materials is often the most justifiable reason for developing a product. Such cheapness, however, may be illusory in that the quantum and steadiness of availability of the raw material may not be sufficient to produce a product profitably. High processing costs could offset the cheapness of the material.

1.8.2 Scale of operation

The annual turn over of new product or group of new products should be such as to ensure profits. The scale of operations must, therefore, be suited not only to the quantum of raw materials available, but to the overall profitability as well.

1.8.3 Consumer need

In the scale of a food product the consumer response is related to purchasing power. The economic stratum of the consumers at whom the product is directed will determine whether the product would be marketable. The new product must fill or create a consumer need.

.9 Fish Product Development

As consequence of technological innovations as well as international competition, many commercially important fish species are over harvested, thus depleting the stocks. Approximately 30% of the total landings can be considered as underutilized, by-catch, unconventional or unexploded. Most of these underutilized fish belongs to the abundantly available pelagic species, which are landed as by-catch during commercial fishing operation of targeted seafood like shrimp. A need for their conservation and utilization for human consumption has been recognized in order to prevent post-harvest fishery losses.

The inherent problems of by-catch are their extreme heterogeneity of composition, bony structure, dark flesh, small size, unattractive appearance and texture, strong flavor etc,

Many of the species are difficult to process by congenital techniques and if processed they face poor marketability. The development of value added products from underutilized fishes stand a step further to satisfy the customer expectation.

The shelf life stability of underutilized fish species is of almost importance in their effective utilization for production of acceptable products. Fish is prone to rapid spoilage due to bacterial activity, lipid oxidation and autolytic changes. Low value fish are generally landed in mixed lots of different species. Due to their lack of commercial importance, generally they are not immediately iced or stored into individual species. The shelf life of such mixed lots vary even under ideal conditions, depending on the species constituting each lot.

Recovery of flesh by mechanical means is perhaps the only viable means of utilizing many underutilized species, whole fish and filleting wastes, by-catch, pelagic and freshwater sources. The unacceptable characteristics of protein of many underutilized fish species can be reversed by such process and thereby offer better possibilities for their use.

1.10 Value Added Fish Product

The term value added refers to value that is added to the product from the times it enters the processing plant to the times it leaves or simply, it decribes the process which increase the product worth.

In order to increase profits, processing of state gradually incorporate low value fish into different processing lines to produce innovative value added product. The end product must of course be quite attractive in the market.

1.11 The Importance of Value Added Product

The main factor behind value addition include----

i. The current trend of " microwaveable" products flooding the market, especially the convenience stores and super markets, is supported by peoples liking of microvevable foods over deep fried foods. This trend may soon catch up in India.

ii. There is an increasing number of working women who find shortage of time.

iii. By-products, by-catch and / or trash fish trimings or rejects of other fish processing industries and meat of low value species such as Sharks, Tilapia, Dhoma etc can be used. Even broken shrim pieces can be used to produce battered and breaded or surimi based shrimp products.

1.12 Advantages of Value Added Fish Products

Value added products are ready to cook, ready to serve, hygenically prepared, nutritious and are packed attractively. Their advantages are

i. Drastic reduction in time and effort to prepare for the table.

ii. Avoids thawing, reprocessing and repacking_ where taste and flavour of the product is lost.

iii. Offer a wide choice of attractive wholesome nutritious and safe food.

iv. It is more profitable compared to mere raw material processing.

v. Reduction of wastage.

A wide variety of VAP both for export and internal market based on fish, shrimp, lobster, squid, cuttle fish, bivalves etc. have been identified. The technology for their production is readily available.

1.13 The Extruder

An extruder is one among the unique pieces of the food machines which shapes the materials by extrusion. It is a high temperature short residence time bioreactor that transforms an immense variety of raw ingredients into modified intermediate and finished products.

1.14 Extrusion

The term 'Extrude' means to sape by forcing through a specially designed opening after a previous heating of the material. Extrusion cooking can be defined as the process by which moistened, starchy and/or proteinaceous materials are plasticised and cooked in a tube by combination of high pressure, intense mechanical shear and heat to create fabricated products of varying texture(Smith,1971). In short , food extrusion is a high temperature short time (HTST) process in which a food material forced to flow, under one or more variety of conditions i.e., mixing

heating and shear through a die which is designed to form and/or dry the extrudate(Renser and Miller,1973) .

1.15 Food extrusion

Food extrusion has been practiced for over fifty years. Its role was initially limited to mixing & forming cereal products. Although thermoplastic extrusion has been successful for starch products, extrusion of proteins has achieved only limited success. Texturisation of Soya protein is the only commercial success, processing approximately 70 million tonnes of raw material annually. Related to fisheries, the major extruder works includes the development of the products with Soya bean protein and surimi , extruded rice flour and minced Dhoma and carp, texturisation of Sardine meat with defatted soya-flour, extruded fish minced from flying fish etc.,

The first food extrusion involved the use of piston or ram type extruders to stuff casings in the manufacture of sausages and processed meats . The development of simple food chopper or mincer , consists of a screw which forces soft food products through die-plate, fortunately may have been the fist use of a single-screw extruder. This two examples of food extruders were used by the meat industry existing today in a remarkably similar forms.

This primitive/piston or ram type extruder is used in different regions of India to prepare starch or pulse based fried snacks. These type products are very popular among the people

of the region. Spirals (Chakli) is one such popular starch product in Maharashtra and south India. Attempts were made to incorporate fish in this traditional food to enhance its taste, flavour and nutritive value. The primitive ram or piston type of extruder was used for the preparation.

REVIEW OF LITERATURE

Chapter-2

REVIEW OF LITERATURE

2.1 Minced Fish

Minced fish is the flesh separated in a comminuted form from the skin, bone, scales, and fins of a wide range fish species.

The low priced fishes constitute a good source of protein and their composition is comparable to that of other popular varieties of fish (Anon, 1962).

Extruder processing was very well reviewed by Mustakas(1970). The review stressed mainly on that extruder processing mainly used for improving nutritional quality and flavour keeping quality of full fat soy flour.

Chakrabarty (1972) reported studies on the development of dehydrated curried mince.

Indian butterfish, croakers and ribbonfish were used by Setty *et al.*, (1974) in deboned, partially hydrolyzed form.

Rudra setty, et al.,(1974) reported that the utilization of trash fish for human consumption studies on the preparation and standardization and shelf life of fish spirals and fish sevu.

Minced fish meat can be used as ingredient in many composite products. The ubiquitous fish cakes, rissoles and eroquettes are generally bonded with cereals flours or starches(Morchesd, 1974).

Minced fish offers an excellent raw material for production of wafers. Fish wafers become a delicacy, among urban population of India. Since minced fish can be kept under chilled/frozen storage, it has become easy for them to produce wafers even when fish is not available(Gopakumar et al., 1975).

Kutty Ayyappan et al., (1976) studied the proximate composition of low priced fishes from Bombay.

In India, the preparation of frozen mince from anchovies (*Thrissocles spp.*), croaker (*Johnius dussumeri*) and other species has been studied by Ghadi and Lewis (1977) and Ghosh *et al.*(1977).

Mince blocks are a major commodity in international trade. they are only intermediates in the manufacture of final retail products. These include battered fingers, steaks, sticks and cakes(Kuriyan, 1977).

Mince fish can be conveniently used for the preparation of fish cutlets. The mince is cooked to remove excess water to get a firm and fibrous texture(Joseph, Jose, 1984).

Gopakumar, 1977 reported that kneaded products can be made either from whole fish or frozen surimi. When frozen surimi is used, partially thawed surimi is placed in a silent cutter or ribbon blender for further thawing and mixed with other ingredients.

Kurian (1977) reported fish product development in India.

Harper, J.M.,1978, explained about low cost extrusion cooking.

Strucutured mince products, the patties, have been developed by Morris and Dawson in 1979 using functional additives such as salt, phosphate and alginate.

Whittle et al., (1980) has shown that the quality of fish minces is dependent not only on the raw material but also on the nature of the separation process. The process sequence, the equipment used and the operation conditions can all influence the potential usefulness of the final mince product

Nair and Gopakumar (1980) worked on development and storage of dehydrated salt mince from low priced fish.

Smith et al.,1980, discussed clearly the high temperature, short time extrusion cooker system and its process technology, factors that control production efficiency and product quality.

Anderson et al., 1981, explained the preparation of high fibre cereal product with crisp bread character in extrusion cooking.

Kamaboko, a fine textured elastic fish sausage, is prepared form surimi by grinding, blending, shaping and heat stabilising (Grantham, 1981).

Molina et al., 1983, explained the characteristics of whole corn: Whole soybean(70:30) and rice: whole soybean (70:30) mixture processed by simple extrusion cooking.

Miller, 1985, has reported about low moisture extrusion effects on cooking moisture of product characteristics.

Rice -bran stabilization by extrusion cooking for extraction of edible oil have been critically reviewed by Randall et al.,(1985).

Joseph et al., (1986) reported that the minced fish have lesser-frozen life compared to fillets and whole fish. The mixing of bone marrow exudate, catheptic enzymes, enzymes from blood, lipids in inorganic constituents in the minced fish affect texture, flavour and appearance and reduce shelf life during frozen storage.

Dosady, 1986, has explained that extruded product characteristics are immensely effected by the extent of starch transformation during extrusion cooking process.

Joseph and Perigreen (1989) studied about suitability of low-priced fish for preparation of cutlets.

Pillai (1989) reported quick salted fish cakes from ribbonfish.

The intermediate moisture shrimp and canned and frozen products based on fish developed by Chakrabarty (1990). The storage stability tests of the products were performed. The changes in microbiological status, total volatile base, peroxide value and free fatty acids on storage were reported.

Effect of extrusion process variable on microstructure of blends minced fish and wheat flour were broadly recapitulated by Suvendu Bhattacharya et al.,(1990).

According to Abraham et al., (1991), minced fish is an important ingredient in the production of variety of seafood product in many countries for its several advantages such as better yield, easiness in incorporation with stabilizers, flexibility in product preparation and suitability in blending.

Dora et al., (1991) reported that minced fish flesh is widely used as an intermediate product for fabricated foods including Kamaboko, fish sausage, imitation products, fish balls, fish burger, fish stick and similar products.

New protein texturization process by extrusion cooking at high moisture level have been explained by Cheftel et al.,(1992).

Surimi based dried fish cake was prepared from minced fish. The minced fish prepared from the fillets of the scianeid fish *Lutjanus spp.*(Basu, 1993).

Gopakumar(1994), reported that fibrous nature of minced fish and cooked fish can be increased by mechanical forces like extrusion process.

Development of crispy extruded products by using 15% spray dried shark protein powder and 85% corn starch was explained by Venugopal, 1994.

Venugopal and Shahidi, 1995, have thoroughly studied about the preparation of value added products from under-utilized fish species. they also described a study by subjecting the underutilized minced meat into extrusion with starch based products.

Fish fingers can be prepared from minced fish. The battered and breaded products is flesh fried, frozen and packed. the fingers can also be prepared from frozen slabs of fish fillets(Gopakumar, 1997).

Basu and Suja (1998) reported development of extruded dried fish products.

MATERIALS AND METHODS

Chapter-3

MATERIALS AND METHODS

3.1 Methods of Preparation of Minced Meat

Dhoma (*Otolithus argentius*) was dressed by removing head, scale and visceral parts, after split opening of belly.

i. Washing:Dressed fish was washed thoroughly with portable water to remove adhering visceral blood, scales etc.
ii. Boiling:The fish was boiled for about 10-12 minutes.
iii. After boiling, skin was removed and muscle separated from central bones manually along with small bone.
iv. And the meat was collected.

3.2 Methods of Preparation of Fish Chakli

Maida flour/wheat flour/rice flour was mixed with minced meat paste, water, red chilli powder, salt, sodium carbonate, sodium bi-carbonate, ginger and garlic and made into dough of required consistency. The soft dough was then extruded through hand operated piston type extruder and given the shape of spirals. The spirals(Chakli) was then deep fried in grondnut oil at low flame to golden brown colour.

3.3 Biochemical Tests

3.3.1 Determination of moisture content (FAO,1983).

i. Principle:

The moisture content is expressed as the loss of weight of the product under certain drying conditions, which is carried out by drying the samples at elevated temperature (102 to 103^0C).

ii. Procedure:

For moisture determination approximately 5g sample was taken in a previously weighed petridish. The petridish along with sample was weighed again and difference is calculated. The petridish along with sample is then placed into an oven at temperature of 102 to 103^0 C and left over night.

The following day, the warm petridish is transferred into the dessicator for cooling. The cooled petridish weighed in an electric balance. The same procedure of drying and weighing repeated till the constant weight is obtained. The difference in the weight of the sample is equal to the moiture content of the given sample which is calculated by the following formula and expressed in percentage.

iii. Calculation:

A= wt. of petridish with sample before drying(gm).

B= wt. of petridish with sample after drying(gm).

C= wt. of petridish(gm).

Miosture = A-B/A-C x100

Moisture = _____%.

3.3.2 Protein Estimation: (Kjeldahl's Method)

i. Principle:

The method is based on the conversion of organic nitrogen to inorganic nitrogen(digestion according to Kjeldahl). The ammonium sulphate thus formed is diluted and made alkaline with sodium hydroxide and the ammonia distilled-over is caught in a known amount of boric acid solution and total nitrogen present in the sample estimated. The total nitrogen multiplied by 6.25 gives the protein content.

ii. Procedure:

a. Digestion:

About 2g of the sample is accurately weighed and put into the digestion flask followed by 20ml of concentrated sulphuric acid and 1.6g of digestion mixture.

The flask is placed over the heater in an inclined position for boiling. The sample is boiled for 2 to 3 hours till the solution becomes clear. The clear solution is allowed to boil for 30 minutes more. The flask is cooled and solution is transferred into 250ml volumetric flask. Volume is made upto 250ml by adding distilled water.

b. Distillation:

Kjeldahl's distillation unit is arranged, steam generated, 1ml of sample solution transferred to the distillate tube followed by washing with distilled water and addition of 1-2 drops of phenolphthalein indicator and 2ml of 40% NaOH and again funnel

is washed with distilled water. A conical flask containing 10ml of 2% Boric acid with one or two drops of Tashiro's indicator was placed on the receiving end of the condenser. The tip of the condenser was dipped inside the solution and about 20ml of the distillate was collected. Contact between the condenser tip and distillate was broken and distillation continued for 2-3 minutes, to steam out the condenser, when pink boric acid solution in receiving flask turns green. The green solution in the flask is then titrated against N/50 sulphuric acid till the end point green to pink is obtained.

iii. Calculation:

1ml of N/50 H_2SO_4 = 0.28mg of N_2

Volume of N/50 H_2SO_4 used = 0.28 x _____mg N_2

1ml of H_2SO_4 extract contains = _____mg N_2

250ml of H_2SO_4 extract contains = 250 x ____mg N_2

250ml of H_2SO_4 extract was prepared from 2g of sample.

2gm sample contains = _____mg N_2

therefore 100g sample contains = 100/2 x_____mg N_2

3.3.3 Determination of salt content (FAO, 1981)

i. Reagents:

0.1N $AgNO_3$

Potassium chromate indicator solution (1% W/V in water)

ii. Method: Approximately 2g of representative sample is accurately weighed and macerated in distilled water for about 2

minutes. Extract transferred quantitatively into a 250ml volumetric flask and made upto volume. 25ml aliquot of this are titrated againt 0.1N $AgNO_3$ using potassium chromate indicator till the yellow colour changes to red.

iii. Calculation:

$$\%NaCl = \frac{\text{Titer value} \times 0.1 \times 58.5 \times 100 \times 250}{1000 \times 25 \times \text{sample weight}}$$

where,

0.1 -Normality of $AgNo_3$

58.5-Equivalent wt. of $AgNo_3$

100- 100g of sample

250- 250ml of aliquot

25ml- filtrate taken

1000ml- 1L

NaCl = _____%.

3.3.4 Determination of fat content (Soxhlet method)

i. Principle

Determination of fat content of the moisture- free sample is carried out by extraction of the fat with suitable solvent of 35-40°Cboiling point. On evaporation of the solvent, the fat is left behind in the flask. The difference in the weight of the empty flask and the flask with fat gives the fat content of the sample.

ii. Procedure

Moisture-free sample approximately of two grams was transferred carefully in an already weighed extraction thimble and weighed. The thimble was placed in the extraction tube of soxhlet apparatus, which was connected to an already weighed empty flask on the lower end and the condenser on the upper end. The extraction flask is filled with sufficient amount of diethyl ether, until siphoning began. Once the lower flask got filled with ether, the heating mantle was switched on to 35°C. The ether collected in the extraction flask was siphoned 5-6 times per hour. The ether was then allowed to collect in the extraction tube until the thimble was immersed in the solvent and was left over night, so as to extract the maximum possible fat.

The following day, the heating mantle was switched on and the solvent siphoned for another 5-6 times. The apparatus was allowed to cool and the thimble removed.

The heating system was set on again and solvent was collected in the extraction flask below the siphoning level. The apparatus was again cooled and the ether was collected out. This procedure was continued until traces of solvent remained in the bottom flask. The flask was then removed and dried in the oven for 10-20 minutes at 45°C The flask was then cooled in the dessicator and weighed.

iii. Calculation

100-%moiture = %dry matter (A)

wt. of thimble with sample - wt. of empty thimble = wt. of dry sample(B).

wt. of wet sample = Bx100/A=Z

wt. of flask with fat-wt. of empty flask = wt. of fat (C)

%fat = 100 x C/Z

3.3.5 Determination of Ash content (A.O.A.C.1995)

i. Principle

The inorganic residue as oxides, sulphates, silicates and chlorides left behind when the dry muscle sample is heated to temperatures of 500-600°C in a Muffle furnace is the ash content of the sample.

ii. Procedure

The sample was carefully taken in a already weighed porcelain crucible and weighed again. First ashing is commenced by heating over a burner until the sample is completely charred and immediately placed in an already heated Muffle furnace for 5 hours. The temperature of the furnace was maintained at 500-600°C. The crucible was then cooled in a dessicator and cooled to room temperature and weighed.

iii. Calculations

A= wt. of the sample (gm)

B= wt. of crucible with crude ash (gm)

C= wt. of empty crucible (gm)

Ash content = B-C/A x 100

Ash content = _____%

3.3.6 Estimation of total volatile bases by Conway Method (1947)

i. Principle:

Known weight of the sample is deproteinised with 7% TCA. This solution is allowed to react with saturated potassium bicarbonate, which liberates the volatile bases. These liberated volatile bases are absorbed by an acid. The excess acid is titrated with an alkali.

ii. Procedure

20gm of sample is taken and grounded in a mortar using distilled water. Add 20ml of 20% TCA solution. Mixture is grounded well.

It is filtered and residue is washed with distilled water containing a few drops of TCA. This protein free filtrate was made upto 100ml.

iii. Estimation

Conway cups and lids are washed with distilled water and dried. Paraffin wax and Vaseline in ratio 1:3 is melted and cooled. This is applied on the rim of the cup. One ml of N/100 H_2SO_4(N/70 HCl) is added into the inner chamber of cup. Lid is placed over the conway cup, covering part of outer chamber and

complete inner chamber. 1ml TCA extract is poured into outer chamber with another pipette. The cup is completely covered with lid immediately after this. The contents were mixed by rotating the unit gently and then unit was left over-night for reactions at room temperature(it can be kept inside an incubator at 36 degrees for 2 hours).

The excess acid left in inner chamber is titrated against N/100 NaOH(N/70 NaOH) using a drop of Tashiro's indicator till the greenish end point is obtained. A blank is run simultaneously.

iv. Calculation

$$\text{Volatile base} = \frac{\text{titrated value x } 0.14\text{x}100}{\text{amount of sample x}100\text{mg\%}}$$

Volatile base =_____mg% of TVN.

3.3.7 Estimation of α- amino nitrogen (C.G.Pope and M.F.Seven's Method)

i. Principle

The method of formation of soluble copper compounds through the reaction between the amino acid and excess of copper in the form of $CuSO_4$. The amount of copper taken into the solution by amino acid is then determined iodimetrically.

ii. Theory

Amino acid occurs in fish tissue in free state in addition to intact protein. However, by adding TCA solution at 5% concentration, protein can be precipitated, leaving free amino acid in the extract. Treatment with copper salt like copper phosphate, cupric chloride or copper sulphate can solublise amino acid in copper amino complex compound which has a dark blue colour depending upon the concentration of amino acid.

iii. Method

Quantitatively copper amino complex compound can be maeasured calorimetrically by measuring cupric ions or iodimetrically. Howenver, insoluble form of copper is preferable and for this purpose, the pH of the extract is to be increased to alkaline side of pH around 8.5-10. The acid TCA is neutralized and made alkaline to the desired level by adding 4% NaOH drop by drop until the indicator colour changes to blue.Copper phosphate suspension obtained by mixing cupric chloride along with tri-sodium phosphate and borate buffer, make all the cupric ions to remain in insoluble form of suspension containing cupric borate and phosphate.

iv. Preparation of TCA extract

20gm of sample was taken and grounded in the mortar by adding 20cc of 7% TCA. The mixture was grounded well, filtered and the residue was washed with distilled water containing few drops of TCA. The protein free filtrate was made upto 100cc.

v. Procedure

10cc of TCA extract was taken into a 50cc volumetric flask.A few drops of thymopthalein indicator were added and the extract was made alkaline by adding normal NaOH, till a distinct blue colour appeared. One part of volume $CuCl_2$ solution was mixed with two part of volume of ammonium phosphate and two parts of volume of borate buffer. The solution was mixed well and 30cc of suspention was added to alkaline solution in standard flask(extract). The volume was made upto 50cc with distilled water. After shaking, it was allowed to stand for 15 minutes and then filtered. 10cc of the filtrate was pipetted out into a conical flask, 0.5cc of glacial acetic acid(CH3COOH) was added followed by addition of 2gm Potassium iodide. The liberated iodine was titrated against N/100 sodium thiosulphate using starch as an indicator. When yellow solution of iodine becomes faint yellow, few drops of starch solution was added and titration was continued till blue colour disappeared.

vi. Calculation

1ml N/100 $Na_2S_2O_3$ = 0.28mg of alpha amino nitrogen.

α- amino nitrogen = titrated value x 280mg%.

3.3.8 Estimation of non-protein nitrogen (Kjeldahl's Method)

i. Principle

The Method is based on the conversion of inorganic nitrogen (digestion according to Kjeldahl). The ammonium sulphate then formed is diluted and made alkaline with sodium hydroxide and

ammonia distilled over caught in a known amount of boric acid solution and total nitrogen present in the sample estimated. The total nitrogen multiplied by 6.25 given the protein content.

ii. Procedure:

a. Digestion:

15ml of 7% TCA extract was taken in the digestion flask followed by 20ml concentrated H_2SO_4 and 1.6gm of digestion mixture.

The flask is placed over the heater in an inclined position for boiling. The sample is boiled for 2-3 hours till the solution becomes clear. The clear solution was allowed to boil for 30 minutes more. The flask was cooled and solution was transferred into volumetric flask (100ml). Volume was made upto 100ml by adding distilled water.

b. Distillation

Kjeldahl's distillation unit was arranged, steam generated, 2ml of the sample solution was transferred to the distillate tube followed by washing with distilled water and addition of 1-2 drops phenolphthalein indicator and 4ml of 40% NaOH and again funnel was washed with distilled water. A conical flask containing 10 ml of 2% boric acid with 1-2 drops Tashiro's indicator was placed on the receiving end of the condenser. The tip of the condenser was dipped inside the solution and about 20ml of the distillate was collected. Contact between the condenser tip and distillate was broken and distillation was continued for 2-5

minutes to steam out the condenser, when pink boric acid solution in the receiving flask turns green. The green solution in the flask was titrated against N/50 H_2SO_4 till the end point green to pink is obtained.

iii Calculation

1ml of N/50 H_2SO_4 = 0.28 mg of N_2.

Vol. of N/50 H_2SO_4 used = 0.28 x _____mg N_2

5ml of H_2SO_4 extract contains = _____ mg N_2

250ml of H_2SO_4 extract contains 250/5x ___mg N_2

2gm of sample contains _____mg N_2

100gm of sample contains 250/5x100/2x___mg N_2

Non-protein nitrogen = _____ mg %

3.3.9 Determination of free fatty acids (IS:5734, 1970)

i. Principle:

During storage fat may become rancid as a result of peroxide formation at the double bonds by atmospheric oxygen and hydrolyzed by micro organisms with the liberation of free acid. The amount of free acid present therefore, gives an indication of the age and quality of fat.

ii. Procedure:

The oil extracted from the sample (25gm) by adding 50gm of sodium sulphate and required quantity of chloroform and filtered it. 15ml of fish oil(chloroform extract) was taken in a

conical flask and heated on the heater till all chloroform get evaporated. Taken 15ml of neutral alcohol and added in flask which is having oil , the flask was already weighed. Then titrated the sample with 0.1N NaOH until slight pink colour appears, this pink colour persisted for atleast 30 seconds.

iii. Calculation:

The FFA was calculated and expressed as percentage of oleic acid by the formula.

% of free fatty acid = volume of alkali x Normality of alkali x 282/wt. of fish oil.

3.3.10 Determination of Peroxide value (Lima et al, 1981)

i. Principle

Fish lipids are highly unsaturated, they can easily undergo oxidation and give rise to peroxy or hydroxy radicals by free chain mechanism which gives peculiar rancid flavour. Saturated potassium iodide solution after reaction liberates iodine which can be titrated against N/500 sodium thiosulpbhate solution using starch as indicator.

ii. Prodedure

Extracted oil 1-2gm(10ml of chloroform extract) was taken in a corning glass stoppered bottle or iodine flask. To this, 15ml fat solvent chloroform and 15ml of glacial acetic acid and 0.5gm of potassium iodide(1.2ml of saturated potassium iodide) solution was added and kept in dark for 4-5 minutes.

After 4-5 minutes, 30ml distilled water was poured in the flask by washing the glass stopper. 1ml of starch solution was added and shaken well. Contents of the flask were then titrated against N/500 sodium thiosulphate solution. A blank was run simultaneously using the reagent under identical conditions.

iii. Calculation

The peroxide value was calculated by deducting blank reading form experimental value which is expressed in milli equivalents of peroxide/1000 gm of oil.

Peroxide value(ml of N/500 $Na_2S_2O_3$ - blank) x 2/wt. of oil
=_____milli equivalent/1000gm of lipid.

3.3.11 Total plate count by spread plate method

Total plate count is the quantitative estimation of the total bacteria present per gram of the sample.

i. Procedure:

a) Preparation of nutrient agar:

Peptone-.5gm
Sodium chloride-.5 gm
Yeast extract - 0.2 gm
Beef extract -0.1gm
Agar -1.5 gm

100 ml of distilled water was taken in conical flask of 250 ml capacity and above materials except agar were dissolved in it by

heating the conical flask in a water bath.Then pH was adjusted with normal NaOH at 7 and then agar was dissolved in it. The mouth of the flask was plugged with cotton.

b) Sterilization of Petridishes

14 sets of petridishes were cleaned, dried and wrapped with brown paper. Small pieces of cotton were wrapped pressed inside the upper opening of 6 pipettes and were placed in pipette holder. The pipette holder were kept in an electrically operated oven and sterilized at 180°C for one hour.

c) Sterilization of saline distilled water and nutrient agar media

In a 250 ml capacity conical flask, 90 ml of .85% saline distilled water was taken .The conical flask was plugged with cotton. Four test tubes with 9 ml of .85% saline distilled water were also taken and plugged with cotton plugs. The agar media, conical flask with 90 ml of distilled water and the test tubes were covered with brown paper and sterilized for 15 minutes under 15 pounds pressure. The conical flasks and test tubes were cooled. The agar was set on water bath to maintain it in molten condition.

d) Inoculation

The sterilized petridishes were arranged around gas burners. The glass mortar and pestle, scissors and forceps were ı alcohol and setting fire to them.

The molten agar was poured in the 14 petridishes and left for some time for solidification. Solidified petridishes were kept in incubator at 40-43°C for 25-30 minutes and again arranged around gas burner.

10g of sample was taken with the help of forceps and scissors and macerated with the mortar pestle. 90ml sterilized saline water was added to it. This dilution was noted as 10^{-1}.

With the help of pipette, 1ml of this dilution was transferred carefully in the vicinity of the gas burner to a test tube, previously marked. The test tube was gently rotated to allow proper mixing. this dilution is 10^{-2} . From the same test tube(10^{-1}), 0.1ml each was added into two petridishes. With the help of a spreader, it was gently spreaded over the nutrient media and then covered and kept in inverted position.

Spreader was sterilized with alcohol and setting fire in each operation.

1ml of 10^{-2} dilution was transferred by a fresh pipette in the vicinity of the gas burner to a test tube, previously marked. The test tube was gently rotated to allow proper mixing. This dilution is 10^{-3}. With the same pipette 0.1ml of 10^{-2} dilution solution was poured in two petridishes and then spread with spreader as previously mentioned.

10^{-4} dilution was also done in the same way as mentioned previously and similarly spreaded.

With another sterile pipette 0.1ml of sterile saline water was pipetted into last petridishes and marked as blank.

All petridishes were inverted and incubated at room temperature for 48 hours

e) Count

After 48 hours the bacterial colonies were counted. Each colony is considered to represent a single bacterium. Count below 30 and above 300 were not considered. The product of the number of colonies and reciprocal of the dilution multiplied by 10 gives the total number of bacteria per gram of fish muscle.

RESULTS AND DISCUSSIONS

Chapter-4

Results and Discussion

First trials were made to prepare the conventional chakli without adding fish. Refined maida-flour was tried . The dough made was too sticky and elastic and extrusion through piston type forming machine was very difficult . The product after frying was very hard and was not acceptable.

Little hot oil was added to the flour and mixed and then hot water was used to make the dough in a bid to improve the dough characteristics. But little improvement was there and the dough was still sticky and elastic, making extrusion difficult. The fried product was hard, to render itself unacceptable.

Coarse wheat-flour(aata) was also tried along with hot oil and hot water without much improvement.

Addition of fish to the dough made the situation worse and the hardness of the fried product increased.

Next, rice-flour was tried. Little hot oil and required volume of hot water was added to make the dough to get proper texture of the final fried product, the dough was kept for one hour before forming. But during forming, the chakli developed cracks and while frying the chakli broke into pieces. Further trial showed that

addition of oil was not necessary. Instead of hot water, use of cold water in dough preparation gave better dough characteristics and the forming was easier. No cracks developed. The retention of dough for one hour before forming, as done with wheat flour did not add any special characteristics to the final product. So dough was prepared using required quantity of water and formed into chakli using forming machine without any retention time. The chakli so prepared was deep fried at low flame in ground nut oil ,until it attained desired golden-brown colour. Thus the conventional chakli was prepared.

Next, fish was introduced in phased manner. Sciaenid (Dhoma) fish meat was used for the experiment. Fish were purchased from Versova landing center and brought to the laboratory. Fish were washed and scales and gut were removed. Fish were then boiled for 10 –12 minutes in water. The meat of the boiled fish was picked manually after it was cooled to room temperature. Initial trails were carried out using 20,30 and 40 gm of dhoma fish meat for 100gm of rice-flour. The product was good but fish smell was not prominent. So it was successively increased to 50, 60, 70, 80 and 90 gm per 100gm of rice flour. With the increase of fish the flavour progressively increased. But with 90gm of fish per 100 gm of rice flour, the product become blackish in colour after frying. So the maximum amount of fish that could be incorporated without affecting the colour is 80 gm per 100 gm of rice flour.

To reduce the toughness of the product with the addition of fish and increase the puffing characteristics, thereby reducing

toughness and improving crispiness, carbonate and bicarbonate mixture was tried. 0.75, 1 and 1.5 gm of each was added for 100 gm of rice flour. Optimum puffing and crispiness was obtained by using 1gm each of sodium carbonate and Sod. Bicarbonate per 100gm of rice flour.

But use of Sod. Carbonate gave soapy taste in the final product, so only Sod. Bicarbonate was tried and it was found that 1gm of Sod. Bicarbonate per 100gm rice flour gave optimum puffing and crispiness and good flavour.

Next it was tried to enhance fish flavour in the product by using ginger and garlic, without imparting any flavour of the spices. It was found that 1gm ginger and 0.5 gm garlic per 100gm rice flour gave the product with increased fish flavour. In addition of that 2gm of red chilly powder and 2.5 gm of salt was added for the taste. So the final recipe of the product as approved by the taste panel is present in Table No. 3.

Table 3: Recipe of the product developed

Component	**Weight (per100 gm)**
Rice flour	100 gm.
Fish meat	80 gm.
Sod. Bicarbonate	1 gm.
Chilly powder	2 gm.
Salt	2.5 gm.
Ginger	1 gm.
Garlic	0.5 gm.

During frying care should be taken that the spirals (Chakli) are deep fried in groundnut oil. Frying should be uniform and should be carried out in low flame. It should be fried to golden_ brown colour. The fried products are removed from oil, drained, cooled to room temperature and packed in 100 guage polyethylene bags for storage. The proximate composition of the product is shown in table 4.

Table 4: Proximate Composition of the Product:

Component	Percentage
Moisture	3.03
Ash	1.87
Protein	16.60
Fat	29.40
Carbohydrate (by difference)	49.10
TOTAL	100

The changes in the TVBN values during storage is depicted in figure-2, while that of NPN, alpha amino nitrogen and total bacterial count are presented in fig. 3, fig. 4 and fig. 7, respectively. It is seen that the TVBN, NPN and alpha amino nitrogen values increased slowly as the storage period progressed showing gradual protein degradation by bacteria which also increased with storage period. Peroxide value (fig. 5) and free-fatty acid value (fig. 6) also increased gradually with storage period showing the extent of fat degradation. However the acceptability of the product was not influenced by the changes in these properties. The acceptability was dependent on the

Fig. 1; Changes in moisture during storage

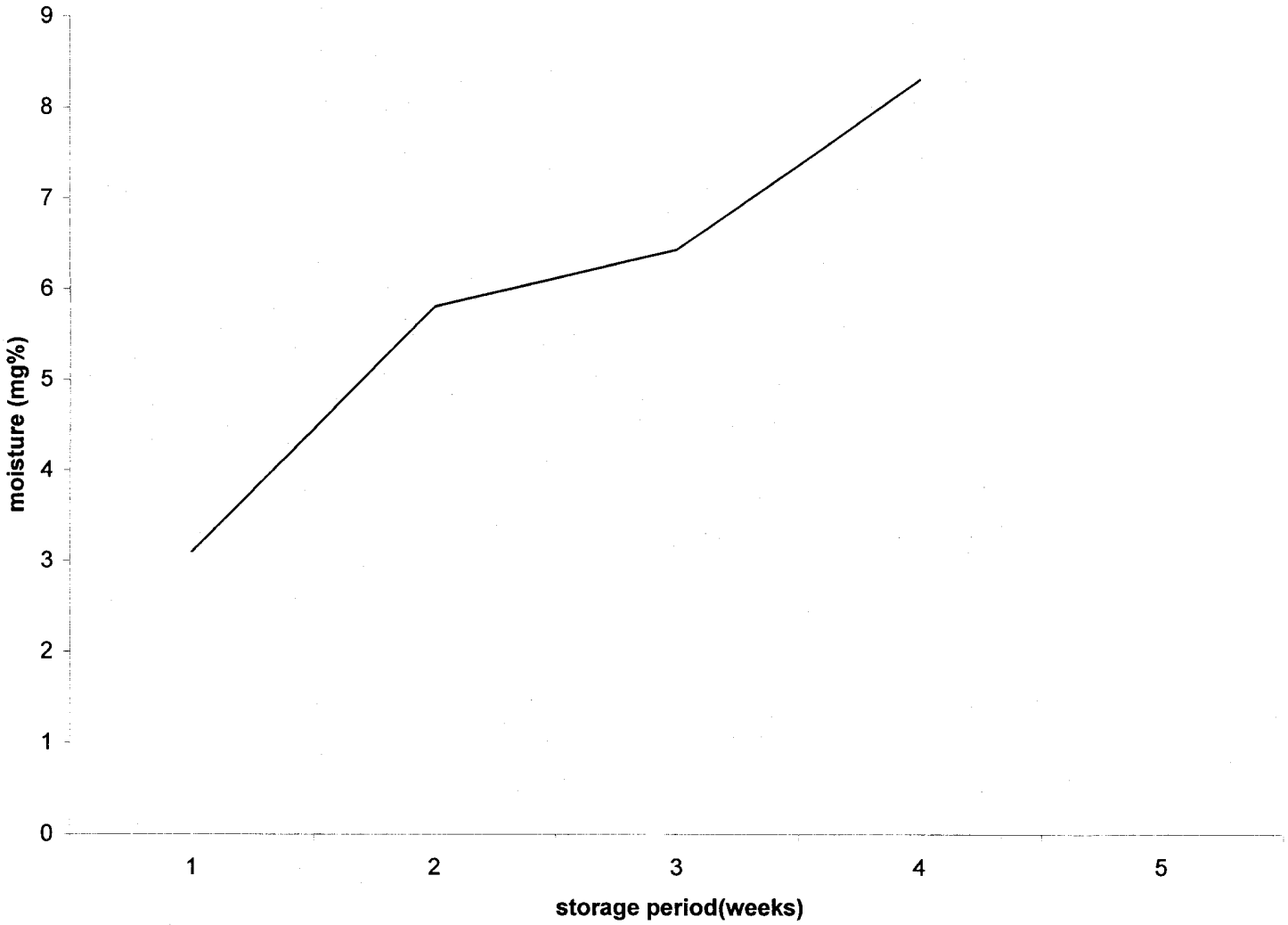


Fig.2: CHANGE IN TVBN DURING STORAGE

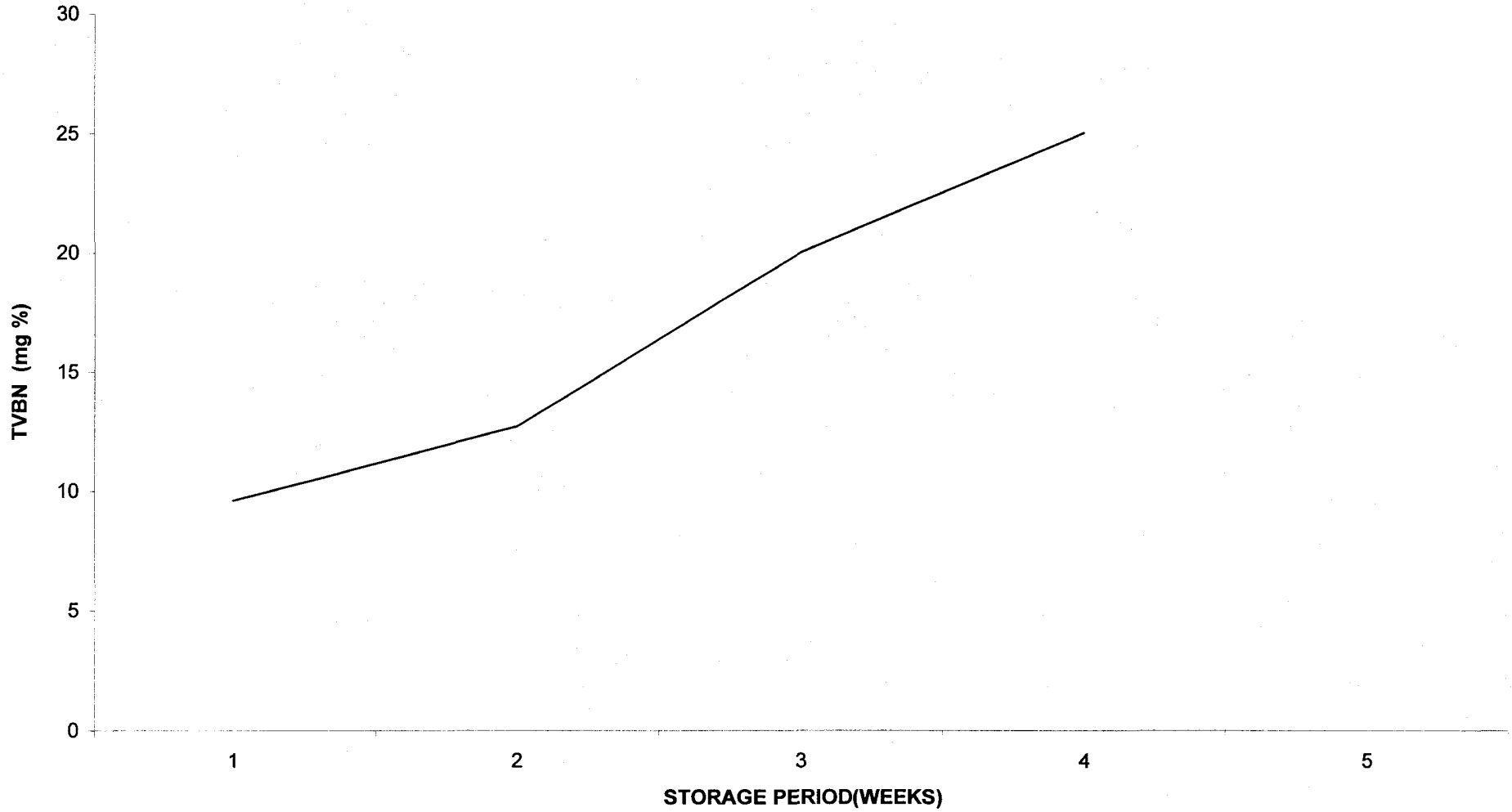


Fig:3; CHANGES IN NPN DURING STROGE

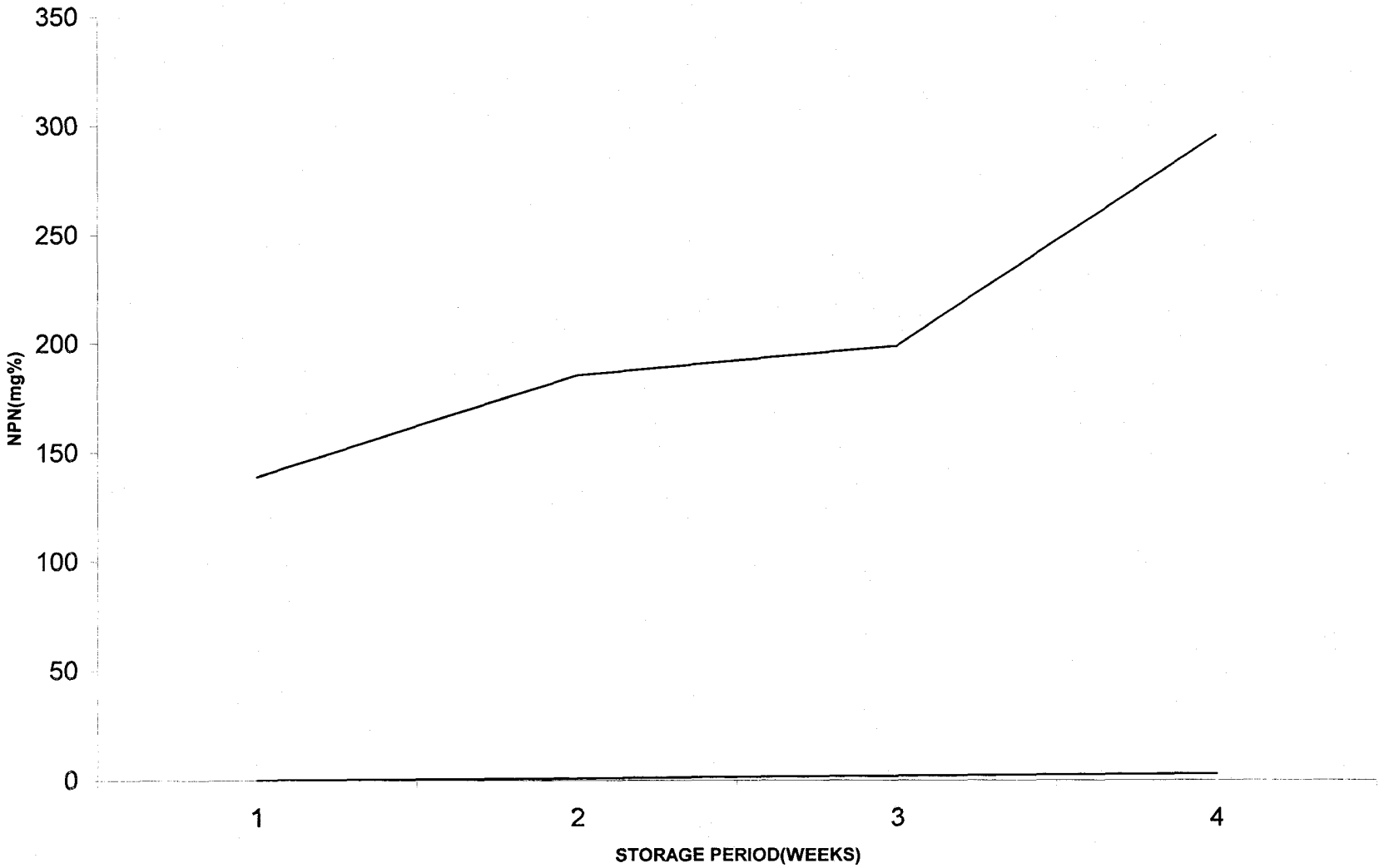


Fig. 4; CHANGES IN α-AMINO NITROGEN DURING STORAGE

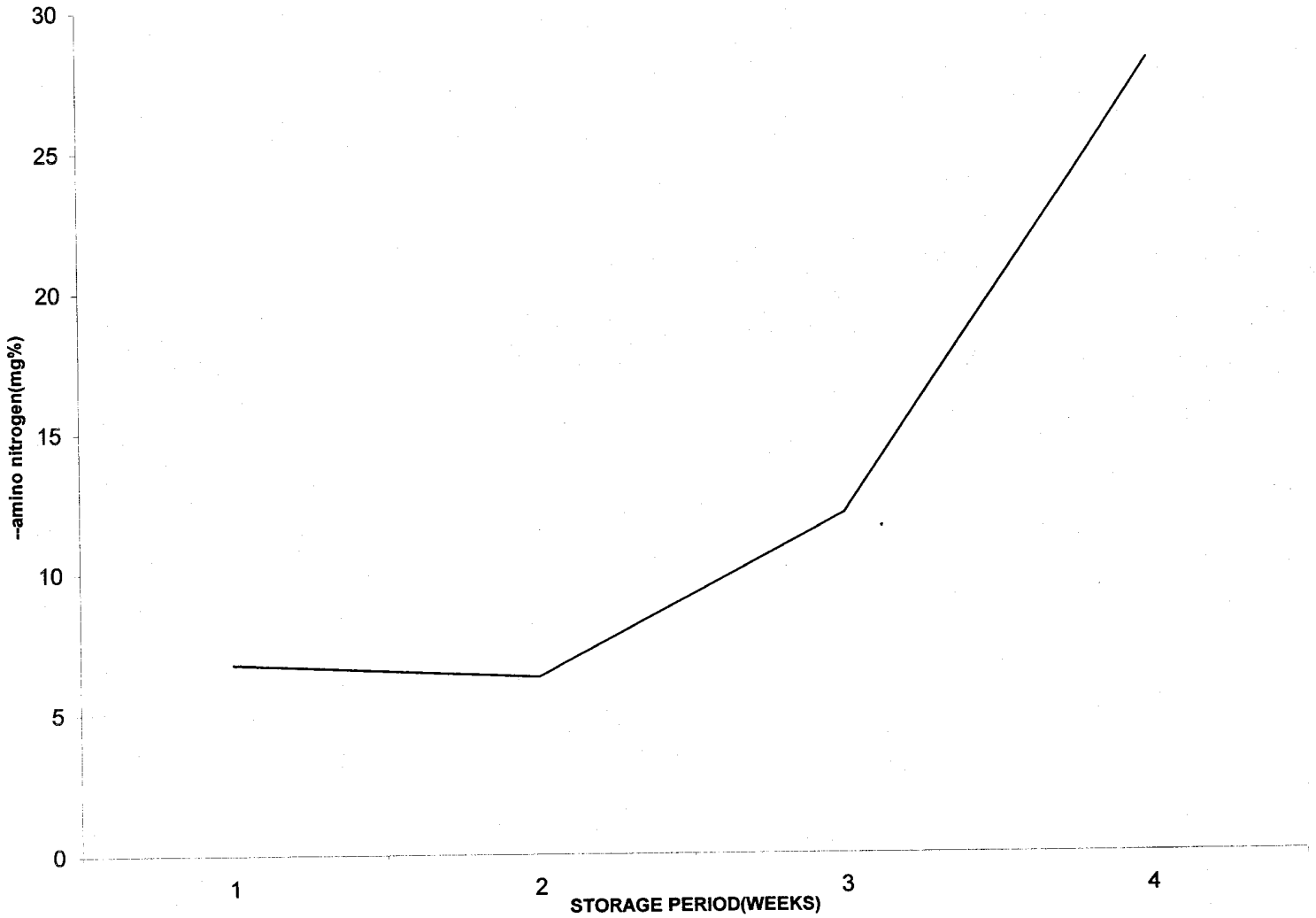


fig. 5: CHANGE IN PV DURING STORAGE

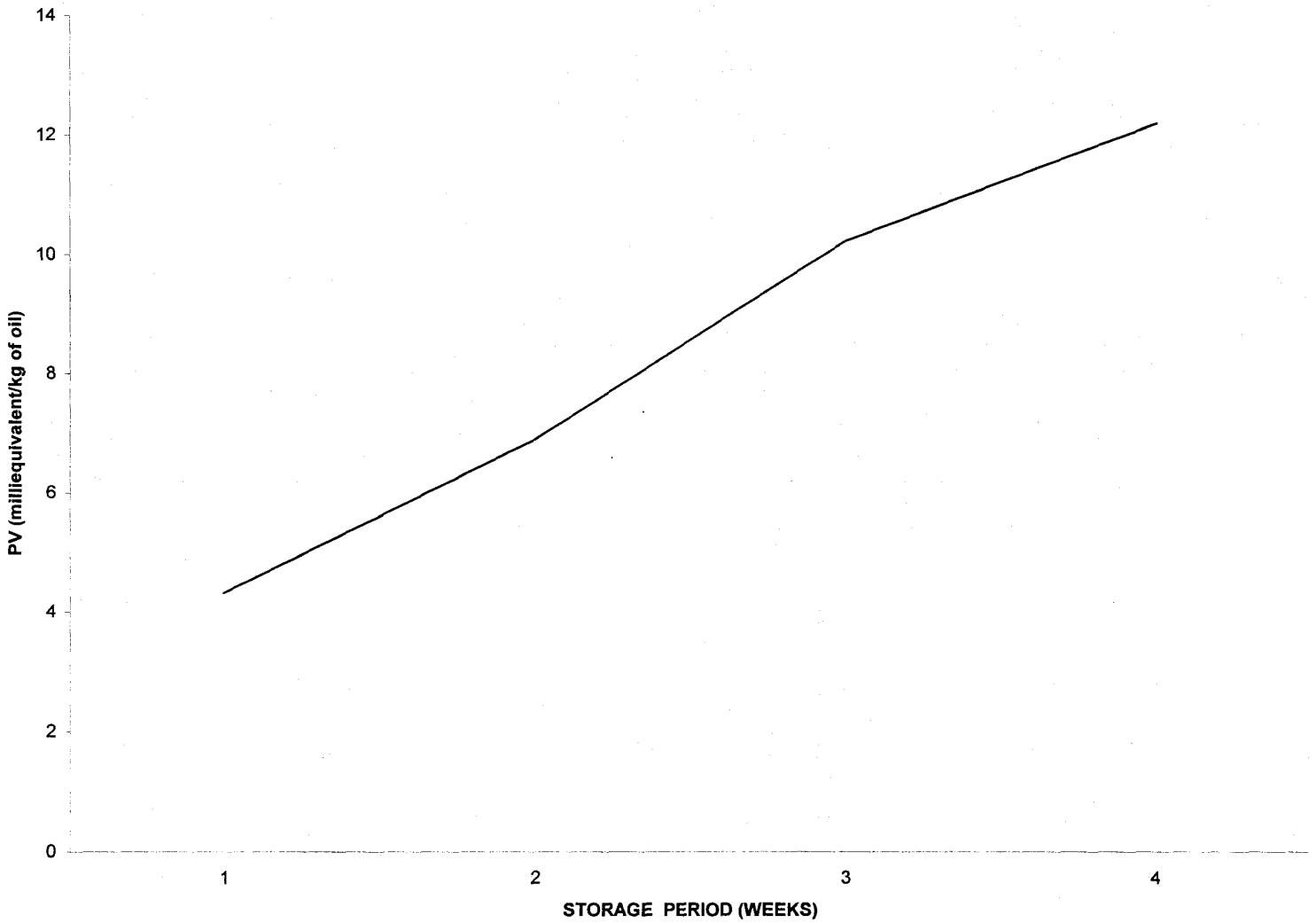


Fig. 6: Changes in FFA during storage

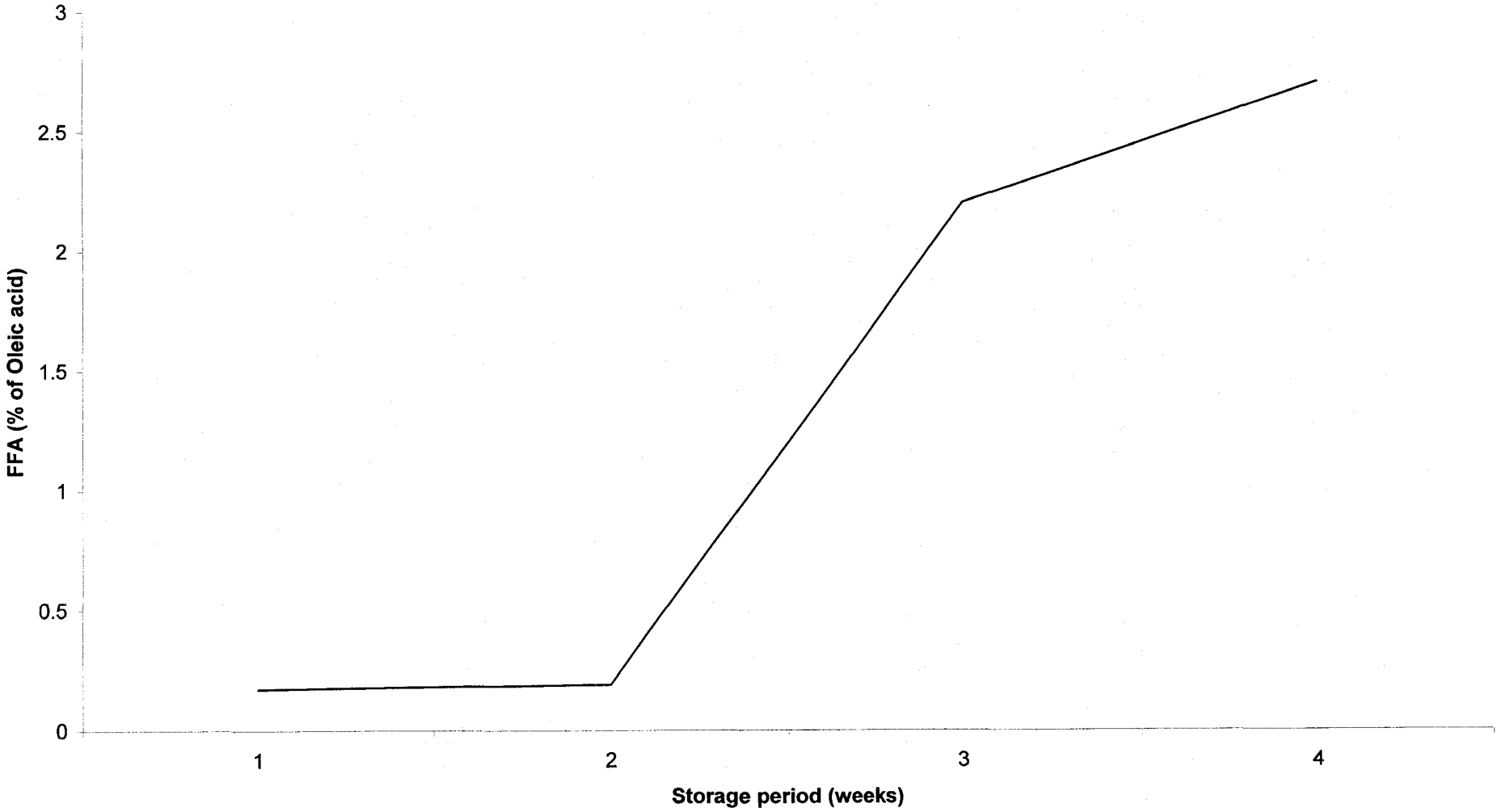
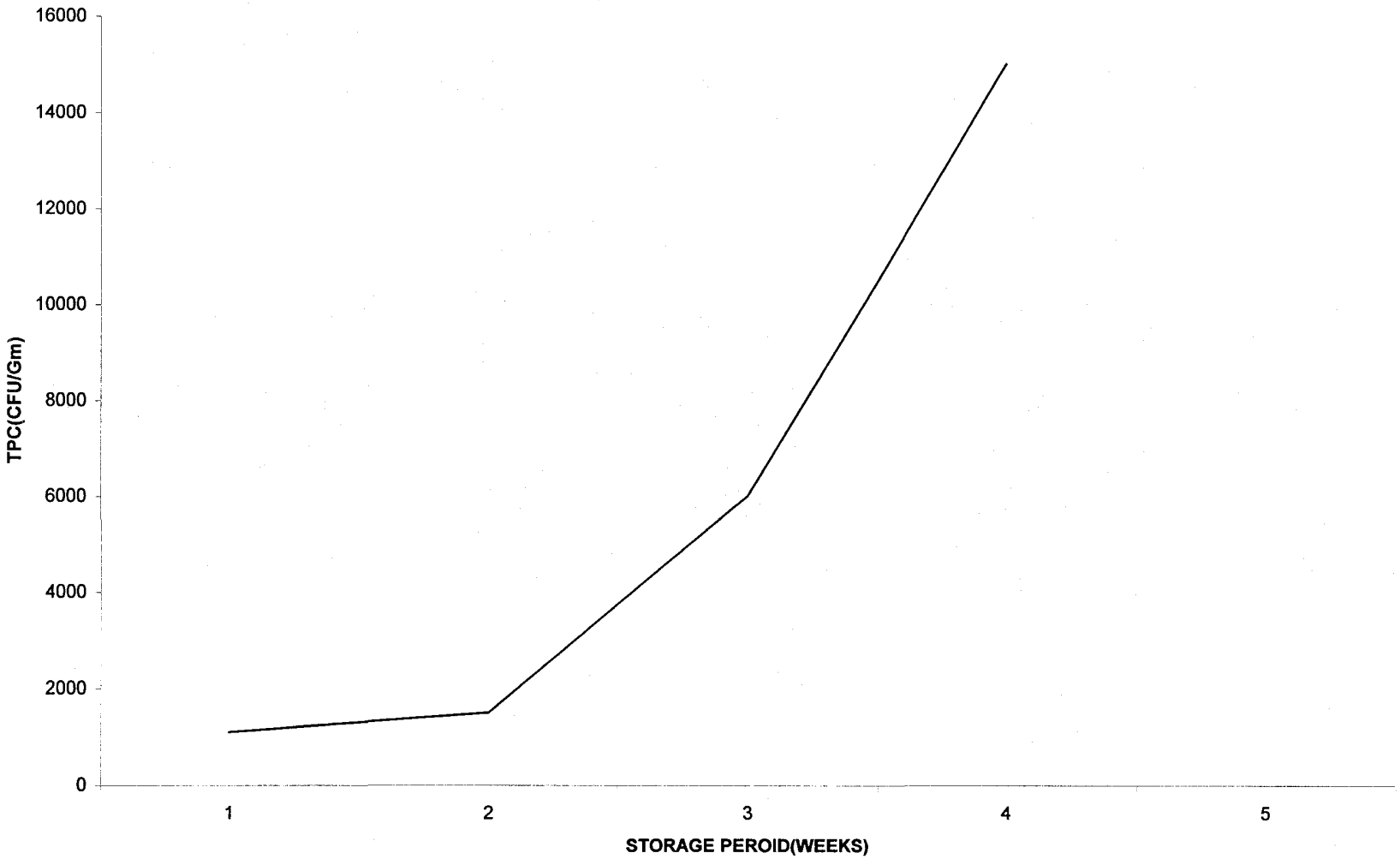


Fig. 7: CHANGES IN TPC DURING STORAGE



crispiness of the product, which was dependent on moisture content. Moisture content increased gradually with storage period.

A thorough study was made to find correlation between moisture, crispiness, flavour and overall acceptability. The result is presented in Table No.5.

The storage characteristics of the product is shown in table 5

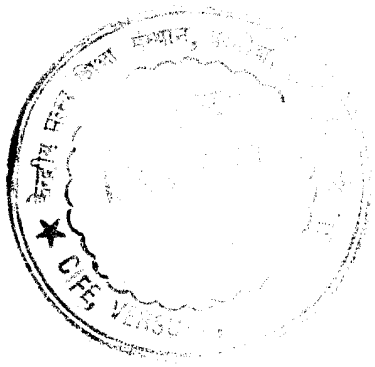


Table 5:

Storage Characteristics of the Product

PERIOD OF STROGE (WEEK)	MOISTURE (%)	TVBN (mg%)	NPN (mg%)	α-amino nitrogen (mg%)	PV (milliequivalent/ Kg of oil)	FFA (% of oleic acid)	TPC (CFU/Gm)
0	3.1	8.0	139.0	6.76	4.32	0.17	$1.1*10^3$
1	5.8	9.6	185.4	6.28	6.89	0.19	$1.5*10^3$
2	6.43	12.7	198.9	12.05	10.22	2.2	$6.0*10^3$
3	8.3	20.0	295.5	28.14	12.19	2.7	$1.5*10^4$
4	----	25.0	----	---	-----	-----	---

A thorough study of the moisture content and crispiness and other Organoleptic quantities was made which is observed as

The organoleptic evaluation revealed that, till the moisture was below 6.5%, the product was excellent and there was no loss of crispiness, the flavour was quite fresh. As the moisture content went beyound 6.5, the crispiness reduced slowly but was quite acceptable till the moisture remained below 8.5. Above this level the product lost its crispiness beyond acceptable limit. A score of 5 was taken as limit of acceptability. Although there was no off flavour developed, the product lost its acceptability due to its loss of crispiness.

So, the product was in prime acceptable condition till 14 days and was quite acceptable upto 21 days. Beyond 21 days it was not acceptable due to loss of crispiness. The flavour was also deteriorated little bit.

Table 6: Organoleptic Evaluation of the Product

No. of days in storage	Moisture (%)	Flavour	Crispiness	Overall acceptability
0	2.93	9	9	9
2	3.15	9	9	9
5	4.12	9	9	9
7	4.96	8.5	8.5	8.5
10	5.60	8.0	8.0	8.0
13	6.23	7.5	8.0	8.0
14	6.42	7.5	8.0	8.o
16	7.4	7.0	7.5	7.5
18	8.1	6.5	7.0	7.0
19	8.2	6.5	6.0	6.0
21	8.4	6.5	5.5	5.5
25	8.9	5.0	4.0	4.0

Where,

9 point----- Headonic scale

9 Like Extremely

8 Like Very much

7 Like Moderately

6 Like Little

5 Neither Like Nor Dislike

4 Dislike Little

3 Dislike Moderately

2 Dislike Very much

1 Dislike Extremely

*A score of 5 is taken as the limit of acceptability.

SUMMARY

Summary

Chakli is a traditional cereal based ready to eat fried product, very popular in Maharashtra. An attempt was made to incorporate fish protein into this traditional product. Fish chakli was prepared by incorporating 80gm of wet fish muscle per 100gm of rice flour. The final fried product has approximately 3% moisture, 16.6 percent protein and about 30% fat. It has got excellent crispy texture and good fishy flavour. The product was packed in 100 gauge polyethylene bags and its storage characteristics were studied at room temperature. Biochemical, bacteriological and organoleptic evaluation revealed that the product remain in prime condition upto 14days. After that period the product becomes little less crispy due to increase in moisture content, however it remains in acceptable conditions upto 21 days. Consumer acceptability study conducted involving large number of people showed that the product become very popular.

सारांश

इस शोध में प्रचलित चकली बनाने की सामग्री में मत्स्य प्रोटीन का समावेश कर विकसित स्वाद एवं पौष्टिकता वाली चकली बनाने का एक सफल प्रयास किया गया । प्राय: चकली मैदा, मूंग, चना, चावल आदि के आटें अथवा इन आटों के मिश्रण द्वारा तैयार तली हुई खाने के लिए तैयार एक स्वादिष्ट एवं महाराष्ट्र राज्य का एक अति लोकप्रिय व्यंजन है । इस संस्थान की मत्स्य परिसंस्करण प्रयोगशाला में इस पारंपारिक उत्पाद चकली बनाने के लिए मत्स्य प्रोटीन का समावेश किया गया । मत्स्य चकली तैयार करने के लिए 100 ग्राम चावल के आटे में 80 ग्राम पका हुआ मत्स्य खीमा एवं स्वादानुसार अन्य मसालों का समावेश किया । खाने के लिए तैयार उत्पाद में 3 प्रतिशत आर्द्रता, 16.6 प्रतिशत प्रोटीन एवं 30 प्रतिशत वसा की मात्रा पाई गई । मत्स्य चकली बहुत ही कुरकुरी एवं एक अच्छी मत्स्य सुवास वाली थी । इस उत्पाद को 100 गैज मोटी पौलीथीलीन थैलियों में पैक कर कमरे के तापक्रम पर संग्रहित किया गया एवं उनकी गुणवत्ता का अध्ययन किया गया । संग्रहण के दौरान उत्पादन में होने वाले जैव रासायनिक, जैवाण्विक एवं भैतिक परिवर्तनों का अवलोकन रसायनिक, सूक्ष्म जीव परिक्षणों द्वारा किया गया । उपरोक्त परिक्षणों द्वारा निष्कर्ष निकाला गया कि उत्पाद 14 दिन तक अपनी प्रारम्भिक द्वारा निष्कर्ष निकाला गया कि उत्पाद 14 दिन तक अपनी प्रारम्भिक अवस्था में स्वादिष्ट एवं कुरकुरा बना रहता है ।

परन्तु इसके उपरांत उत्पाद में आर्द्रता वृद्धि के कारण कुरकुरापन कम हो जाता है । फिर भी उत्पाद 21 दिन तक खाने योग्य अवस्था में रहता है । इस उत्पाद मत्स्य चकली के लिए उपभोक्ता की पसंद नापसंद का एक अध्ययन कर उत्पाद को काफी लोकप्रिय पाया गया और लोगों ने उत्पाद के प्रति अपनी रुचि दर्शायी ।

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