

INCORPORATION OF SPIRULINA ALGAE IN INTEGRAL PASTA: A REAL PROTEIN MEAL (FORTIFIED FOOD PRODUCT)

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Technology degree in Biotechnology

by

Raajalakshmi Premnath (37230064)



**DEPARTMENT OF BIOTECHNOLOGY
SCHOOL OF BIO AND CHEMICAL ENGINEERING**

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

**Accredited with Grade "A" by NAAC | 12B Status by UGC | Approved by AICTE
JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI – 600 119**

April – 2021



SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

Accredited with Grade "A" by NAAC | 12B Status by UGC | Approved by AICTE

Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai – 600 119

www.sathyabama.ac.in

DEPARTMENT OF BIOTECHNOLOGY

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of Raajalakshmi Premnath (37230064) who carried out the project entitled "INCORPORATION OF SPIRULINA ALGAE IN INTEGRAL PASTA: A REAL PROTEIN MEAL" Under our supervision from January 2021 to February 2021.

Internal guide

Dr. R. THYAGARAGAN

External guide

Mr. G. ANBARASAN

HEAD OF THE DEPARTMENT

Dr.V. RAMESH KUMAR

Submitted for Viva voce Examination held on 16.04.21

Internal Examiner

External Examiner

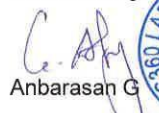
Date: 02.03.2021

BONAFIDE CERTIFICATE

This is to certify that this project report is the bonafide work of Ms. Raajalakshmi Premnath, (Register no: 37230064) who carried out the project entitled "INCORPORATION OF SPIRULINA ALGAE IN WHEAT PASTA: A REAL PROTEIN MEAL" under my supervision from January to February 2021.

We wish All the best on Completion of her project with us.

With best regards,


Anbarasan G
Manager – Lab

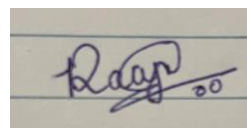


DECLARATION

I Raajalakshmi Premnath (37230064) hereby declare that the Project Report “INCORPORATION OF SPIRULINA ALGAE IN INTEGRAL PASTA: A REAL PROTEIN MEAL done by me under the guidance of Dr. R. Thyagarajan, Assistant Professor, Department of Biotechnology at SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY, CHENNAI and Mr. G. Anbarasan. (External Guide) is submitted in partial fulfilment of the requirements for the award of Bachelor of Technology degree in Biotechnology.

DATE: 16.04.21

PLACE: Chennai

A handwritten signature in blue ink on a piece of lined paper. The signature appears to be 'Raaj' followed by a flourish and the number '20'.

SIGNATURE OF THE CANDIDATE

ACKNOWLEDGEMENT

I am pleased to acknowledge my sincere thanks to Board of Management of **SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY** for their encouragement in doing this project and for completing it successfully. I am grateful to them.

I convey my thanks to **Dr. WILSON ARUNAI**, Pro vice chancellor, Dean, School of Bio and Chemical Engineering and **Dr.V. RAMESH KUMAR** and **Mr. NARENDRA KUMAR**, Head of the Department, Department of Biotechnology, Sathyabama institute of science and technology for providing me necessary support and details at the right time during the progressive reviews.

I would like to express my sincere and deep sense of gratitude to my Project Guide **Dr. R. Thyagarajan**, Assistant Professor, Department of Biotechnology, Sathyabama institute of science and technology for his valuable guidance, suggestions and constant encouragement paved away for the completion of my project work.

I wish to express my thanks to all **Teaching and Non-teaching staff members** of the Department of Biotechnology who were helpful in many ways for the completion of the project.

ABSTRACT

Pasta products are used and established all over the world and at all ages, Pasta was accepted for their nutritional value, low cost and easy to prepare. In recent years, many health products such as seaweed have been used in pasta products. Spirulina is a filamentous turquoise blue microalga that is known to be a good source of protein. According to the recommendations of the World Health Organization, healthy adults need about 0.66 / kg / day, which not only feeds people in the new world, but also negatively affects the environment of animal protein production. To reduce it is necessary to consume nutrients such as algae. A recent study evaluated a high-quality pasta diet composed of algae yields (whole wheat and spirulina) when compared to similar pasta without algae. All products were tested before and after cooking to understand nutritional contents. The nutritional value decreases due to food processing. Such experiments are carried out with dried spirulina products.

Key words: Spirulina platensis / algae / chemical composition / nutrition.

TABLE OF CONTENTS

ABSTRACT	vi
LIST OF FIGURES.....	x
LIST OF TABLES	xi
List of Symbols and Abbreviation	xii
CHAPTER 1	1
INTRODUCTION.....	1
1.1 Healing Health Benefits of Spirulina	3
1.1.1 Potent Alkalizer	3
1.1.2 Detoxifier	3
1.1.3 Skin Health.....	4
1.1.4 Boost's immunity	4
1.1.5 Regulates Blood Sugar.....	4
CHAPTER 2	5
REVIEW OF LITERATURE	5
CHAPTER 3	11
AIM AND SCOPE.....	11
CHAPTER 4	13
MATERIALS AND METHODS.....	13
4.1 METHODOLOGY	13
4.1.1 EQUIPMENTS.....	13
4.1.2 DEVICES	13
4.2 Preparation of Samples.....	14
4.2.1 Scientific classification of spirulina	16
4.4 Determination of protein in pasta product by kjeldahl method,	17
SHRI SOHRAB (Agri & Food), ISI	17
4.4.1 Scope	17
4.4.2 Definition	17
4.4.3 Principle	17
4.4.4 Apparatus.....	17
4.4.5 Procedure (IS: 7219 – 1973)	19
4.4.6 Calculation	20
4.5 Determination of carbohydrate in pasta products (IS 1656: 2007)	20

4.5.1 Procedure for calculating carbohydrates content	20
4.6 Determination of fat in pasta products by acid hydrolysis – IS 1656 : 2007.....	20
4.6.1 Procedure.....	20
4.7 Determination of moisture content in pasta products – IS: 7874 (Part 1) – 1975.	21
4.7.1 Procedure.....	21
4.7.2 Calculation	22
4.8 Determination of Total Ash content in pasta products – IS: 7874 (Part 1)- 1975.	22
4.8.1 Procedure.....	22
4.8.2 Calculation	23
4.9 Determination of pH content in pasta products IS: 7874 (Part 1) - 1975	23
4.9.1 Principle	23
4.9.2 Definitions	23
4.9.3 pH value	23
4.9.4 Procedure.....	23
4.10 Determination of Alcoholic Acidity in pasta products – IS: 1155-1968 Appendix F. 24	
4.10.1	24
4.10.2	25
4.10.3 Procedure.....	25
4.10.4	25
CHAPTER 5	26
RESULTS AND DISCUSSION	26
5.1 Protein.....	26
5.1.2 Protein Content Chart.....	28
5.2 Carbohydrate	29
5.2.2 Carbohydrate Content Chart	30
5.3 Fat.....	32
5.3.2 Fat Content chart.....	34
5.4 Moisture	35
5.4.2 Moisture content chart.....	36
5.5 Ash.....	38
5.5.2 Ash content chart	38
5.6 Total nutritional analysis of regular and fortified pasta.....	39
5.7 Result discussions.....	41

CHAPTER 6	43
SUMMARY	43
CONCLUSION	45
REFERENCES.....	46

LIST OF FIGURES

S. No	Figure Name	Page
4.1	Sample Preparation (Fortification of spirulina in pasta dough)	14
4.2	Raw pasta dough was made into shapes	15
4.3	Pasta was boiled until its cooked completely	16
4.4	Cooked pasta with algae	17
4.5	Distillation assembly	19

LIST OF TABLES

S.no	Table Name	Page No
5.1	Protein content result	27
5.3	Carbohydrate content result	30
5.5	Fat content result	33
5.7	Moisture content result	35
5.9	Ash content results	36
5.11	Total nutritional analysis of regular and fortified pasta	38

List of Symbols and Abbreviation

Symbol	Abbreviation
°C	Degree Celcius
%	Percentage
cm	Centimeter
mg	Milligram
g	Grams
RAP	Raw algae pasta
RPWA	Raw pasta without algae
CAP	Cooked algae pasta
CAWP	Cooked algae without pasta
ml	millilitres
m/v	Mass per volume

CHAPTER 1

INTRODUCTION

Pasta is a not unusual place nutrition of human food regimen because of their nutritive cost, sensory attributes, low fee and brief time preparation. Traditionally synthetic with flour of bleached, semi-entire or entire durum wheat, pasta is a superb nutritional supply of electricity because of its carbohydrate content material. Due to the developing call for purposeful merchandise, pasta manufacturers and meals enterprise were fortified their merchandise with new substances that may offer fitness advantages (e.g., excessive protein reasserts and antioxidants, anti- inflammatory, anti-hypertensive effect.

Proteins are macronutrients that play an important position as structural and purposeful additives of residing systems. The exceptional of nutritional protein consequences from the presence of important amino acids, those who human organism can't synthesize and are best provided via way of means of meals. The nutritional necessities of protein and amino acids, in particular the ones taken into consideration as important to regular human metabolism, relies upon on numerous elements which include developmental stage, physiological status, microbiota withinside the intestinal lumen, environmental elements, and pathological state. Attending to World Health Organisation recommendations, protein necessities for wholesome adults are round 0. sixty-six g/kg/day.

Usually, the protein consumption is supplied via way of means of meals of animal origin, being taken into consideration because the first-rate protein. However, environmental effect troubles in addition to new client traits in selecting non-animal protein (vegetarians and vegans) want to be taken into account. Due to this, new reasserts of nutritional protein, as algae, are wished now no longer best as a manner to feed the world's populace however additionally to lessen the poor environmental effect of animal protein production. Spirulina is a filamentous blue-inexperienced microalga, properly called an amazing supply of protein (50- 70 g/one hundred g) and additionally containing bioactive compounds that may complement the human food regimen. High protein content of Spirulina makes it an appropriate adjunct to combat malnutrition. Spirulina were notably studied because of its high protein

content, micronutrient composition, nutrients and minerals, smooth and fast reproducibility, cheaper and non-poisonous nature.

There is a pressing want of meals or a meal complement which imparts each dietary and medicinal advantages to the society. Such sorts of nutritional dietary supplements are known as nutraceuticals or purposeful meals. Nowadays, microalgae are gaining reputation as a nutritional complement due to low fee, excessive dietary cost and sizable fitness advantages. Spirulina consists of great range of proteins, nutrients, beta-carotene, minerals, polysaccharides, glycolipids and sulfo lipids. Thus, nutritional complementation with Spirulina can be a fee- powerful manner to beautify the balanced meals safety in an herbal manner. The number one function of spirulina that has attracted the eye of each studies employees and industrialists is its wonderful protein content material.

As a part of extra particular analyses, some of capabilities of specific hobby from the dietary point of view were demonstrated: a balanced protein composition and the presence of uncommon important lipids, in addition to several minerals and nutrients. In addition to its dietary hobby, spirulina suggests a few healing residences. It consists of one-of-a-kind materials which have been studied for his or her organic hobby. The immunostimulatory and antiviral residences of spirulina, for instance, are of fantastic hobby withinside the combat in opposition to malnutrition, in view that malnourished youngsters have weakened immune defences.

The protein content material of spirulina is in particular excessive, various among 60% and 70% of its dry weight, and contains nearly all amino acids, along with the important ones. It should, however, be stated that an inexpensive each day intake of spirulina can't offer extra than approximately 15 grams of proteins. This amount represents about 1 / 4 to a 3rd of each day protein necessities for a 60 kg adult (RDA: 0.7 to at least one g/kg). Nevertheless, withinside the case of youngsters struggling malnutrition, it'd be sensible to contain up to ten g of spirulina withinside each day ration. Depending at the weight of the child, this could quantity to extra than 50% of the endorsed protein consumption. The general lipid content material provides an amazing stability among saturated and polyunsaturated fatty acids.

The composition of the principle fatty acids suggests excessive attention of important fatty acids, along with omega-three and omega-6 acids, that are said to save you LDL cholesterol build-up within the body. Spirulina is likewise wealthy in sulfolipids, that are of hobby to researchers because of their defensive hobby in opposition to viral infections. For example, in vitro experiments have proven that the lipid compound sulfoquinovosyl diacylglycerol (SQDG) inhibits the opposite transcriptase of HIV. Carbohydrates make up 15% to 25% of spirulina's dry weight, Spirulina is evidently wealthy in a few important minerals which might be in particular crucial in case of malnutrition.

It is really well worth citing that the contents of fatty acids and sure minerals may be without difficulty changed via way of means of adjusting the cultivation inputs. Microalgae cultivation affords a supply of safe to eat protein, inexpensive and less difficult and with a decrease effect at the environment. Recently, many research files the incorporation of Spirulina and one-of-a-kind seaweed on pasta to beautify their dietary content material and additionally enhance advantages on human fitness. In the existing study, the dietary composition of an imperative pasta with algae (wholewheat) changed into evaluated and as compared with the identical pasta without algae. Particular interest changed into given to the protein content material of the nutrition fortified with algae.

1.1 Healing Health Benefits of Spirulina

1.1.1 Potent Alkalizer

Spirulina is highly praised for its potent alkaline property. It works well by increasing the alkaline level and lowers acidity. Spirulina aid in treating acidosis, lowering internal inflammation and battle gut infections. To get instant relief from acidity take 3 teaspoons of spirulina power mixed in a glass of water on an empty stomach.

1.1.2 Detoxifier

Spirulina is reversed for its powerful detoxifying properties. The natural detoxify agent cleanses the liver and flushes out the toxins from the body. Spirulina is naturally high in chlorophyll and facilitates blood purification by removing harmful toxins. Also Read: Detox Drinks to Cleanse Your Body from Within.

1.1.3 Skin Health

The goodness of spirulina is beneficial to heal various skin ailments like eczema, psoriasis, treat wounds and fungal infections. The antiseptic and anti-inflammatory nature of spirulina mixed with yogurt on the affected skin area to treat fungal or bacterial infections. It also guards the skin against harmful UV rays. Drinking spirulina juice regularly on an empty stomach detoxifies the system and enhances the skin glow and radiance.

1.1.4 Boosts immunity

Spirulina contains Cynodon Dactylon Protein Fraction or CDPF, a protein element responsible for triggering the immune system. In addition, it is also heaped with powerful antioxidants, vitamin A and C which scavenges free radical damages, avert chronic inflammation and keep diseases at bay. Also Read: Vitamin C – Function, Food sources, Deficiencies and Toxicity,

1.1.5 Regulates Blood Sugar

Studies have proved that taking spirulina has shown potent hypoglycaemic effects and controls blood sugar levels. It is also efficient in managing diabetes-related disorders. To prevent blood sugar spikes and to stabilize blood glucose levels, consume spirulina juice regularly on an empty stomach.

CHAPTER 2

REVIEW OF LITERATURE

The use of *S. platensis* as meals has already been suggested because the data of the Spanish colonization in Mexico, and has these days been said withinside the expeditions withinside the African deserts. Several *Spirulina* sp.-primarily based totally meals and dietary supplements were discovered withinside the markets, sponsored through the Food and Drugs Administration (FDA), and labelled as GRAS (usually diagnosed as safe) (Belay 2008; Henriksen 1989; Iyer et al. 2008). The growth in international populace and the prediction of inadequate protein complement have directed to the hunt of opportunity reasserts of protein. *Spirulina platensis* will be beneficial on this regard (Spolaore et al. 2006).

The incorporation of its biomass in nourishment can also additionally convey, further of the primary nutrients, critical bioactive practical products (Anupama 2000; Iyer et al. 2008). A marketplace survey at the intake of pastas, wherein a hundred people had been interviewed, indicated that the pastas had been often ate up through 97% of the men and women that had been interviewed (Silveira and Badiale-Furlong 1998). The low ingestion of fiber in meals may be taken into consideration as a danger aspect for the improvement of practical continual constipation (Gomes et al. 2003).

Preparation of pastas, manufactured from big acceptance, the usage of vital wheat flour can also additionally stimulate the ingestion of an extra amount of fibers through the populace. Several healing residences of the *Spirulina* sp. were suggested. They produce a multiplied scarring of wounds; the phycocyanin can stimulate the immunological machine and the gamma-linolenic acid stimulates the prostaglandin synthesis, which can be worried in law of the blood pressure. It is likewise useful withinside the remedy of unique eczemas and eases the pre- menstrual syndrome; enables withinside the manufacturing of top cholesterol (HDL) and withinside the elimination of terrible cholesterol (LDL) extra from the bloodstream.

It additionally enables in decreasing the coronary and weight problems illnesses because it consists of huge portions of phenylalanine that reduces the hunger. High

contents of intact A diet lessen the dangers of cancer (Henrickson 1989; Richmond 1988). An antioxidant and antimutagenic impact of the chlorophyll and a number of its derivatives consisting of chlorophyllin have additionally been suggested (Azizan and Blevins 1995, Higashi and Okai 1998; Kumar et al. 1999; Ong et al. 1986; Tutour et al. 1998). The biotechnological tactics have a big effect withinside the colouring enterprise due to the fact the cultivation of microorganisms permits the manufacturing in sizeable portions of various materials without relying at the climatic elements and with low environmental effect.

Among the cyanobacteria, the hobby withinside the business manufacturing of *Spirulina* sp. has accelerated because of a few unique residences consisting of excessive protein content (60-70% dry basis), excessive digestibility because of mucopolysaccharide molecular wall, low awareness of nucleic acids and amino acid profile, much like the only advocated through the Food and Agricultural Organization (FAO). In addition, it gives in its composition huge proportions of different bioactive compounds consisting of carotenoids, phycocyanin, chlorophyll, nutrients and polyunsaturated fatty acids, which include the gamma-linolenic and linoleic acids (Branger et al. 2003; Ciferri and Tiboni 1985; Jimenez et al. 2003; Morist et al. 2001; Shimamatsu 2004). From the technological factor of view, it gives benefits because of the low dietary demand, low price of compound extraction and dry biomass (Dillon et al. 1995; Durand-Chastel 1980).

Spirulina has been significantly studied in phrases of utilization in meals in addition to nutritional dietary supplements. A seek question at the bibliographic database PubMed at the fifth of August 2019 led to 309 hits for the keywords "(*Arthrospira platensis*) AND meals". The ensuing guides date again to the yr. 1973. More than 1/2 of of those guides (167 articles) had been posted withinside the closing five years. Despite the developing hobby in spirulina, it's miles nevertheless relatively new (Belay, 2008), mainly to the European marketplace. It has been used as a meal for centuries, however has simplest been commercially to be had for the beyond 50 years (Borowitzka, 1999).

Spirulina, which is assessed as cyanobacterium, is one in all few algae amenable to big scale manufacturing, now no longer least as it grows in an alkaline milieu that is damaging for conventional plants (Devi & Venkataraman, 1984;

Fradique et al., 2010; Habib et al., 2008). The excessive pH of an alkaline habitat means that the boom of maximum different organisms is avoided in order that spirulina grows in extra or much fewer natural cultures (Small, 2011). Furthermore, the environmental footprint of spirulina protein in comparison with conventional protein plants is smaller in phrases of water use, land career and electricity intake (Habib et al., 2008). Therefore, spirulina, as a non-animal-primarily based totally protein, is properly posed to lower our average protein-primarily based totally environmental effect (Di Paola et al., 2017; Smetana et al., 2017) whilst nevertheless keeping critical sensory aspects.

In 1940, a French phycologist Dangeard posted a document at the intake of dihe through the Kanembu human beings close to Lake Chad (Dangeard, 1940). Dangeard additionally referred to those equal algae populated some of lakes withinside the Rift Valley of East Africa, and become the primary meals for the flamingos residing round the one's lakes. Twenty-5 years later at some point of 1964-65, a botanist on a Belgian Trans-Saharan expedition, Jean Leonard, suggested locating a curious greenish, fit for human consumption desserts being offered in local markets of Fort-Lamy in Chad (Leonard, 1966). When locals stated those desserts got here from regions close to Lake Chad, Leonard diagnosed the relationship among the algal blooms and dried desserts offered withinside the marketplace.

In 1967 spirulina become set up as a “exceptional destiny meals supply” withinside the International Association of Applied Microbiology (Sasson, 1997). Analysis of the dietary residences of spirulina confirmed first and predominant an exceedingly excessive protein content, of the order of 60–70 percentage of its dry weight; it additionally confirmed the fantastic exceptional of its proteins (balanced critical amino acid content). These first facts become sufficient to release many studies initiatives for business functions withinside the 1970s, due to the fact micro- organisms (yeast, chlorella, spirulina, a few microorganism and moulds) appeared at that point to be the maximum direct course to less expensive proteins – the iconic “unmarried molecular proteins”.

At the equal time whilst Leonard rediscovered spirulina in Africa, a request become obtained from an agency named Sosa-Textcoco Ltd through the “Institute

Francis du petrol” to look at a bloom of algae going on withinside the evaporation ponds in their sodium bicarbonate manufacturing facility in a lake close to Mexico City. As a result, the primary systematic and designated look at of the boom necessities and body structure of spirulina become performed. This looks at, which become part of Ph.D. thesis through Zarrouk (1966), become the premise for organising the primary big-scale manufacturing plant of spirulina (Sasson, 1997). While in the end no micro-organism fulfilled its promise of reasonably-priced protein, spirulina persisted to offer upward push to analyse and growing manufacturing, reflecting its perceived dietary assets (Falquet, 2000) A.E. Ghaly, Department of Agricultural Engineering, Cairo University, Giza, Egypt aimed to assess the results of including herbal meals flavouring components (annas, cloves, cinnamon, cocoa, chocolate, vanilla, and coconut) and meals colouring components (Raspberry Rose E124, Sunset Yellow E a hundred and ten and Tartrazine Yellow E 102) to conventional Egyptian cookies containing spirulina, as a supply of herbal bioactive molecules, at the acceptability of the odour, flavour and colour of the cookies the usage of a sensory assessment panel of ten members.

The preliminary odour of cookies containing spirulina become musty-seawater to fishy seawater and the flavour become bitter and bitter. The meals flavouring components cocoa, chocolate and cinnamon powders and anise and clove oils affected the flavour and odour of spirulina cookies, however their results did now no longer beautify the acceptability of those cookies. Addition of coconut and vanilla oils progressed the flavour and odour and superior the acceptability of the cookies. They made the flavour delicious, made the odour extraordinarily the colour of cookies containing spirulina become darkish bluish inexperienced.

This bluish inexperienced colour of spirulina shifted toward pink and brownish pink after the addition of the Raspberry Rose E124 and Sunset Yellow E110, respectively. However, the acceptability of those cookies become low because the first introduced salty flavour and the second one introduced bitter flavour to the cookies. Addition of Tartrazine Yellow E 102 superior the acceptability of the cookies colours satisfactory and lots sweeter and considerably accelerated the diploma of acceptance. The colour of spirulina shifted toward brown which become tremendously desirable because the cookies appeared like chocolate cookies. The effects confirmed that including spirulina and coconut and vanilla oils into cookies

accelerated their dietary values. Spirulina and coconut and vanilla oils comprise protein, fatty acids, nutrients and minerals and are wealthy in antioxidants, all of that allows you to have sizeable fitness advantages to high school youngsters in Egypt who be afflicted by malnutrition.

Although there's tremendous hobby in spirulina as a meal for humans, constrained paintings have been posted approximately the nutritive cost of spirulina for chicks and laying hens. Blum and Calet (1976), Yoshida and Hoshii (1980), Becker and Venkataraman (1982), and Brune (1982) fed various degrees of spirulina to developing chickens with great outcomes on the decrease degrees, five to 10%; boom became depressed at degrees above 20%. Similar outcomes had been received while spirulina became fed to laying hens (Nazarenko et al., 1975, Blum et al., 1976; Colas et al., 1979; Sauveur et al., 1979).

Recently, an undertaking became installed on the Oceanic Institute in Waimanalo, Hawaii, to develop pilot portions of spirulina for animal studies. As a part of those studies, a sequence of experiments became designed to assess the nutritive cost of spirulina grown on an artificial medium. The targets of the prevailing observe had been to decide the results of various degrees of spirulina grown on an artificial medium on the subject of the boom and feed performance of developing chickens and to decide the results of spirulina on developing and person Japanese quail.

In 2012 Dr. Lotan A. (Nidaria Technology Ltd., Israel) patented a few biologic sunscreen formulas, which blanketed a mix of algae as lively ingredients. The claimed hobby became the synergistic impact of the simultaneous use of UV filters and algae, which soak up sunlight, "convert it in electricity source", shield the pores and skin and enhance its appearance. However, regardless of the significance of this statement, a simple medical demonstration is missing. The patent proposed 3 formulations containing 10% w/w non-possible intact algae, a topical gel and each W/O and O/W emulsions. Few years later, C. Souza et al., similarly advanced a strong and powerful sunscreen formula containing an aggregate of UV filters and antioxidants (the use of Spirulina among the others).

As such it similarly encourages researchers to layout greater efficacious and dependable sunscreens. As an antioxidant, Spirulina can also additionally lessen pores and skin hyperpigmentation and shield pores and skin towards sun-brought about damages (e.g., photoaging) through inhibiting ROS-brought about harm to the epidermis. Both visible and rheological analyses discovered that the sunscreen formulations had been strong at some point of the observe period. These formulations exhibited a non-Newtonian and pseudoplastic behaviour and, in phrases of safety, in line with the sensorial analyses, they did now no longer aggravate the pores and skin. The C. Souza's studies group tested the photoprotective results of the advanced formulations, each in vitro and in vivo, and highlighted the pivotal contribution of the addition of Spirulina.

The in vitro UVA safety of system F2 and F3 became evaluated through the UVA/UVB ratio and through the crucial wavelength. The in vivo SPF values of each formulations had been almost 30 at the same time as the in vitro SPF values of formulations F2 and F3 had been respectively round twos. five-instances and 3.0-instances better than the ones received in vivo. Therefore, in vitro outcomes endorse that the mixture of Spirulina and SLN loaded DMC with UV filters enhance the SPF cost. However, in vivo checks did now no longer correctly affirm this result. It has been discovered that, at the same time as in vitro test measures the formula transmittance, the in vivo method determines the powerful cap potential to save you inflammatory reaction (erythema) precipitated through sun radiation.

This manner that Spirulina growth the mild scattering houses without furnishing sufficient anti-inflammatory hobby. To similarly make clear the gain of the use of Spirulina into the formulations, a 3-month single-blind medical observe has been performed with forty-four wholesome participants (30–50 years old), at some point of which the water content material of stratum corneum, TEWL, epidermis echogenicity and pores and skin elasticity and pigmentation had been measured. The outcomes confirmed that Spirulina-supplemented sunscreen improves each the fitness of the epidermis and the pores and skin elasticity after eighty-four days of the treatment, with appreciate to the sunscreen itself.

CHAPTER 3

AIM AND SCOPE

AIM:

This thesis explores the growth in dietary portions mainly protein content material of spirulina integrated pasta product (Fortified meals product). Spirulina has many fitness advantages and excessive protein content material, however calls for best fantastically modest situations to grow. Hence it may be visible as a ability part- option to the growing protein want withinside the future, however additionally to update the modern-day manufacturing means. Therefore, low-priced manufacturing systems and extra optimized nutrient ratios must be researched extensively.

AIM AND SCOPE:

The essential contribution of this takes a look at is to offer the proof that a day- by-day consumption of spirulina considerably improves a child's nutritive fitness. The effects from this take a look at suggest that a mixture of spirulina and meal is powerful in enhancing the linear boom in top for undernourished children. The distinctiveness of this takes a look at mission comes with its use of indigenous micro- algae. Utilising an indigenous aid is vital for improvement tasks in phrases of sustainability and acceptability.

In addition, spirulina may be produced with much less water and power than different ingredients promoted as a dietary complement for children, along with soybeans. The considerable water and mild temperature in India are best for cultivation, even though the manufacturing of spirulina is likewise nicely ideal to hot, even wasteland countries. Thus, this vitamins fortification programme may be an excellent device to relieve vitamins troubles in growing countries.

This takes a look at focussed on including spirulina as a nutritional complement in pasta to beef up the meal's product with enriching protein, calcium, iron, diet B12 phosphorus to beautify the inspiration years of a child's life. Spirulina is a blue inexperienced alga having superb dietary fee. It additionally has many healing properties, withinside the equal region the spirulina produces 20 instances extra

protein than soya, and Spirulina usually incorporates approximately 60% protein. It is a superb supply of diet B12, Copper and iron. Spirulina protein is low in energy. There are 3 nine energy in step with gram of protein located in spirulina, which may be as compared to sixty-five energy in step with gram of protein in beef. The researcher brought spirulina in particular amount to meals product recipes of cookies, pasta and noodles. These had been then assessed for his or her nutritive fee beneath Neath regular condition. The effects indicated considerably extended values of protein, calcium, phosphorus and iron will now no longer plenty alternate withinside the flavour of the meals merchandise.

OBJECTIVE

- To efficiently expand the spirulina fortified meals merchandise.
- Nutritional evaluation of vitamins gift withinside the pasta.
- Comparison of the managed pattern with the spirulina fortified samples.

HYPOTHESIS

- The fortified meals merchandise has a better dietary fee as compared to govern samples.
- The Fortified meals merchandise will discover reputation via way of means of humans in phrases of flavour and look as compared to govern samples.
- The spirulina fortified meals merchandise might be wealthy in iron, calcium and phosphorus, therefore it is going to be useful for malnourished children, and lactating moms and different deficiency diseases.

CHAPTER 4

MATERIALS AND METHODS

4.1 METHODOLOGY

The materials that are used for the process are:

4.1.1 EQUIPMENTS:

- Condenser
- Conical flasks
- Digestion flasks
- Heater
- Burette
- Glass pipette
- Beaker
- Filter paper
- Extraction beaker
- Weighing scale
- Aluminium dish
- Meker burner
- Bunsen burner
- Crucible ring stand
- Funnel

4.1.2 DEVICES

- Hydrotherm
- Hydrolysis unit
- Muffle furnace
- Desiccator
- PH meter
- UV-160 Spectrophotometer
- Atomic absorption spectrophotometer

4.2 Preparation of Samples

- Preparation of sample 1(raw) regular pasta dough using key ingredients such as wheat eggs and olive oil.
- Prepare a sample 2(raw) functional pasta dough which is infused with 3% of spirulina.
- Boil the sample 1 (raw pasta without algae) and sample 2 (raw pasta with algae) pasta until it gets cooked completely to get sample 3 (cooked pasta without algae) and sample 4(cooked pasta with algae).
- Compare the Nutritional analysis such as Protein, Total carbohydrates, Fat, Ash content, Moisture content, Ph value, Alcoholic Acidity, Iron and calcium content of raw algae pasta (RAP) sample 2, raw pasta without algae (RPWA) sample 1, cooked algae pasta (CAP) sample 4, cooked pasta without algae (CPWA) sample 3.
- Nutritional analysis for testing moisture content, the cooked sample has been frozen dried after it's been drained.



Fig 4.1 Sample Preparation (Fortification of spirulina in pasta dough)



Fig 4.2 Raw pasta dough was made into shapes



Fig 4.3 Pasta was boiled until it's cooked completely



Fig 4.4 Cooked pasta with algae

4.2.1 Scientific classification of spirulina

- Domain - Bacteria
- Phylum - Cyanobacteria
- Class - Cyanophyceae
- Order - Spirulinales
- Family - Spirulinaceae
- Genus - Spirulina Turpin
- Species – Spirulina plantesis

Spirulina is a type of blue-green algae that is rich in protein, vitamins, minerals, carotenoids, and antioxidants that can help protect cells from damage. Spirulina like any blue-green algae can be contaminated with toxic substances called microcystins. It can also absorb heavy metals from the water where it is grown. For these reasons, it is important to buy spirulina from a trusted brand. Test tube and animal studies suggest spirulina may boost the immune system, help protect against allergic reactions, and have antiviral and anticancer properties. However, there is no proof that spirulina has these, or any, benefits in people. More research is needed. Amino acids make up 62% of spirulina. Because it is a rich source of protein and other nutrients, spirulina has been used as a nutritional supplement. However, although

spirulina contains a certain level of protein, you would need to take very large quantities to see any effect. Other sources of protein, such as nuts, legumes, whole grains, and meat, provide protein in smaller servings.

4.4 Determination of Protein in pasta product by Kjeldahl method, SHRI SOHRAB (Agri & Food), ISI.

4.4.1 Scope

This standard prescribes Kjeldahl method for the determination of total nitrogen content and specifies the factors used in converting nitrogen to protein for various foods and feeds.

4.4.2 Definition

Total protein, by the Kjeldahl method, is defined as the amount of nitrogen experimentally found and multiplied by an appropriate conversion factor.

4.4.3 Principle

The sample is oxidised in the presence of sulphuric acid and nitrogenous compounds are converted into ammonium sulphate. Mercury is added to the digestion mixture as a catalyst and alkali sulphate as a boiling point elevator. Ammonia is liberated by adding an excess of alkali and is quantitatively distilled into a measured volume of standard sulphuric acid. The acid not neutralised by ammonia is back-titrated with standard alkali.

4.4.4 Apparatus

Digestion- Use 500 to 800ml Kjeldahl flasks. Conduct digestion over a heating device adjusted to bring 250 ml water at 2 degree Celsius to rolling boil in 5 minutes. To test heaters, preheat for 10 minutes, if gas, or for 30 minutes if electric. Add 3 to 4 boiling chips or glass beads to prevent super heating.

Distillation- Fit the flask with a rubber stopper through which passes the lower end of a sufficient scrubber trap or bulb to prevent mechanical carryover of alkali during distillation. Connect the upper end of the trap to a condenser by rubber or glass tubing. Immerse the trap outlet of the condenser in such a way as to ensure complete absorption of ammonia distilled over into acid in a 500ml Erlenmeyer flask.

Reagents:

- **Concentrated sulphuric acid** - 93 to 94 percent by mass, nitrogen-free.
- **Mercuric Oxide or Metallic Mercury** - nitrogen-free
- **Potassium sulphate or Anhydrous Sodium Sulphate** - nitrogen
- **Zinc Granules**
- **Sulphite or Thiosulphate** - Dissolve 40 g potassium sulphide or 80 g hydrated sodium thiosulphate in 1 litre distilled water.
- **Sodium Hydroxide** - pellets, flakes or sodium, nitrogen free. For solution, dissolve about 450 g sodium hydroxide in distilled water, cool, and dilute to 1 litre. The specific gravity should be at least 1.36 at 20 degree Celsius.
- **Methyl Red Indicator** - Dissolve 1 g methyl red in 200ml alcohol.
- **Sodium Hydroxide Standard Solution** - Dissolve 1 g methyl red in 200 ml alcohol.

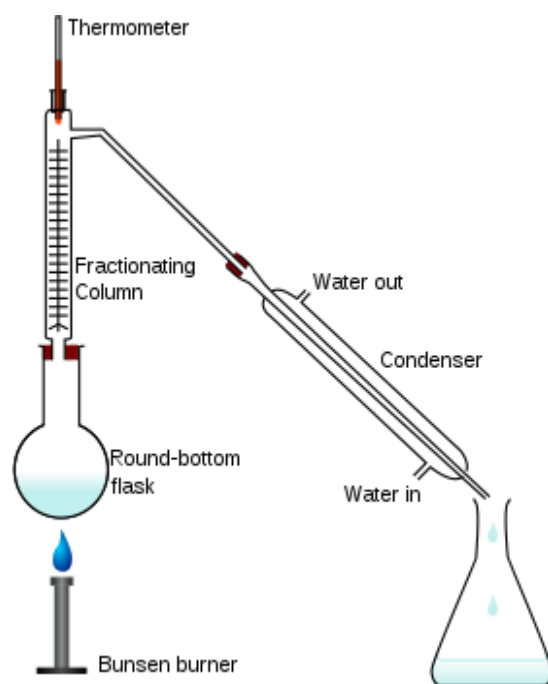


Fig 4.5 Distillation Assembly

4.4.5 Procedure (IS: 7219 – 1973)

- **Digestion**- 0.7 to 2.2g samples have been weighed into the digestion flask and add 0.7 g mercury oxide and 15 g powdered potassium sulphate and 25 ml of sulphuric acid. Ratio of salt to acid (m/v) should be approx. 1:1 at the end of digestion for proper temperature control. Digestion may be incomplete at a lower ratio and nitrogen and nitrogen may be lost at a higher ratio. Flask been placed in an inclined position on a heater and heated gently until foam came to an end, boiled vigorously until solution became clear.
- **Distillation** – cool and add 200 ml of distilled water and 25ml of thiosulphate solution, incline flask and add 25 g of sodium hydroxide solution. Then connect the flask to distillation bulb and condenser tip has been immersed in standard acid (50 ml, 0.5N) and heat it until ammonia disappears. Back-titrate excess acid with standard 0.1 N sodium hydroxide, using metal red as indicator and correct for blank determination in reagent. Protein is calculated based on the nitrogen content. (report nitrogen to nearest 0.01 percent and protein to nearest 0.05 percent).

4.4.6 Calculation

Calculation of Nitrogen Content

Nitrogen content (N) in g = $(a - 0.2b) - (c - 0.2d) \times 0.007$

Where; a = Volume in ml 0.5 N acid measured for main distillation,

b = Volume in ml 0.1 N alkali used for back titrating a,

c = Volume in ml 0.5 N acid measured for blank distillation, and

d = Volume in ml 0.1 N alkali used for back-titrating c.

4.5 Determination of carbohydrate in pasta products (IS 1656: 2007)

4.5.1 Procedure for calculating carbohydrates content

Total carbohydrates are calculated after determining the percentage of moisture, total protein, fat and total ash.

Total carbohydrates, including sucrose, dextrose and dextrin, lactose percent by mass = $100 - (A + B + C + D)$

Whereas, A = Percent by mass of moisture

B = Percent by mass of total protein

C = Percent by mass of fat and

D = Total ash, percent by mass

4.6 Determination of fat in pasta products by acid hydrolysis – IS 1656: 2007.

4.6.1 Procedure

The acid-hydrolysis method extracts fat from the sample by treat it to hydrochloric acid and mixed ethers.

The following steps are taken in the acid hydrolysis procedure:

- **Step 1:** The hydrochloric acid devastates fatty acids from the glycerides, glycolipids, phospholipids, and sterol esters.
- **Step 2:** Acid hydrolysis also breaks lipid-carbohydrate bonds, aids in the hydrolysing of proteins and polysaccharides, and breaks cell walls.
- **Step 3:** All of this makes the lipids available for total extraction with mixed ethers
- **Step 4:** The ether is evaporated, and the extracted residue is weighed.

4.7 Determination of moisture content in pasta products – IS: 7874 (Part 1) – 1975.

Grind about 100 g of the sample so that it passes through 1.00 mm IS Sieve. Alternatively, ASTM Sieve 18 or BS Sieve 16 or Tyler Sieve may be used. Transfer this prepared sample to a well- stoppered glass bottle.

4.7.1 Procedure

- Weigh about 5g of the prepared sample in an aluminium dish with a cover, having a diameter of at least 50mm and a depth of about 40mm.
- Shake the dish until the contents are evenly distributed. With cover removed place the dish and cover in an air-oven maintained at 2 degree Celsius and dry it for 2 hours.
- Place cover on dish, cool in a desiccator and weigh. Repeat the process successive weighing's in less than one milligram.

4.7.2 Calculation

$$\text{Moisture, percent by mass} = \frac{100(M1-M2)}{M1 - M}$$

Where,

M1 = mass in g of the dish with the material before

M2 = mass in g of the dish with the material after drying, and

M = mass in g of the empty dish

4.8 Determination of Total Ash content in pasta products – IS: 7874 (Part 1)-1975.

4.8.1 Procedure

- Weigh accurately about 2g of the dried material flame of a Meker burner for about one hour.
- Complete the ignition by keeping in a muffle furnace at 550 F until grey ash results.
- Cool in a desiccator and weigh.
- Ignite the dish again in the muffle furnace for 30 minutes, cool and weigh. Repeat the process until the difference in mass between two successive weighing's is less than 1 mg.
- Lowest mass is being noted.

4.8.2 Calculation

Total ash (moisture free),

$$\text{Percentage by mass} = \frac{100 (M_2 - M)}{M_1 - M}$$

Where,

M₂ = the lowest mass in g of the dish with ash,

M = mass in g of the empty dish, and

M₁ = mass in g of the with the dried material taken for the test.

4.9 Determination of pH content in pasta products IS: 7874 (Part 1) - 1975

4.9.1 Principle

A pH electrode is used to measure the pH either within a liquid or food homogenate, or at the surface of a solid food sample.

4.9.2 Definitions

pH A measure of the concentration of hydrogen ions (i.e., acidity) in a solution.

4.9.3 pH value

A measure of the pH of a solution expressed as a number on a scale from 0 to 14.

4.9.4 Procedure

- Place the pH 7 and pH 4 or pH 10 reference buffers in a plastic universal
- Sink a digital thermometer with a stream of deionised water and use a tissue paper to remove surplus water.
- Submerge the thermometer in the pH 7 buffer, stir tenderly and wait 1 or 2 minutes for thermal equilibrium. Read the temperature and remove.

- Alter the temperature on the secondary LCD of the pH meter to the temperature displayed on the thermometer.
- Rinse the pH electrode with a stream of deionised water and use a tissue to remove excess water.
- Submerge the electrode into the pH 7 buffer, stir lightly and wait few minutes for thermal equilibrium.
- Press CFM to confirm calibration.
- The meter keeps the reading and the calibrated value is then displayed on the primary LCD and the secondary LCD will display the second anticipate buffer value.
- Wash the pH electrode with a stream of deionised water and use a tissue paper to remove remaining water.
- Submerge the electrode into the 2nd buffer and stir gently.
- When the reading is fixed and close to the selected buffer, “READY” and “CFM” will blink.
- 18) Press CFM to confirm calibration.
- 17) The meter stores the reading and go back to normal operational mode, finishing the calibration.

4.10 Determination of Alcoholic Acidity in pasta products – IS: 1155-1968 Appendix F.

4.10.1 Standard Sodium Hydroxide Solution- Approx. 0.05 N,

4.10.2 Phenolphthalein Indicator Solution- Dissolve 0.1 g of phenol-phthalein in 100 ml of 60 percent (v/v) rectified spirit.

4.10.3 Procedure

- Weigh 5 g of sample into a conical stoppered flask and add 50 ml of neutral ethyl alcohol.
- Stopper, shake and allow to stand for 24 hours, with occasional shaking.
- Filter the alcoholic extract against standard sodium hydroxide solution using phenolphthalein as indicator. Calculate the percentage of alcoholic acidity as sulphuric acid.

4.10.4 Calculation

Alcoholic acidity H₂SO₄ with 90 percent alcohol, present by mass = $\frac{24.52 AN}{W}$

Where,

A= Volume in ml of Standard sodium hydroxide solution used in titration.

N= Normality of Standard sodium hydroxide solutions, and

W= Mass in g of the material taken for the test.

CHAPTER 5

RESULTS AND DISCUSSION

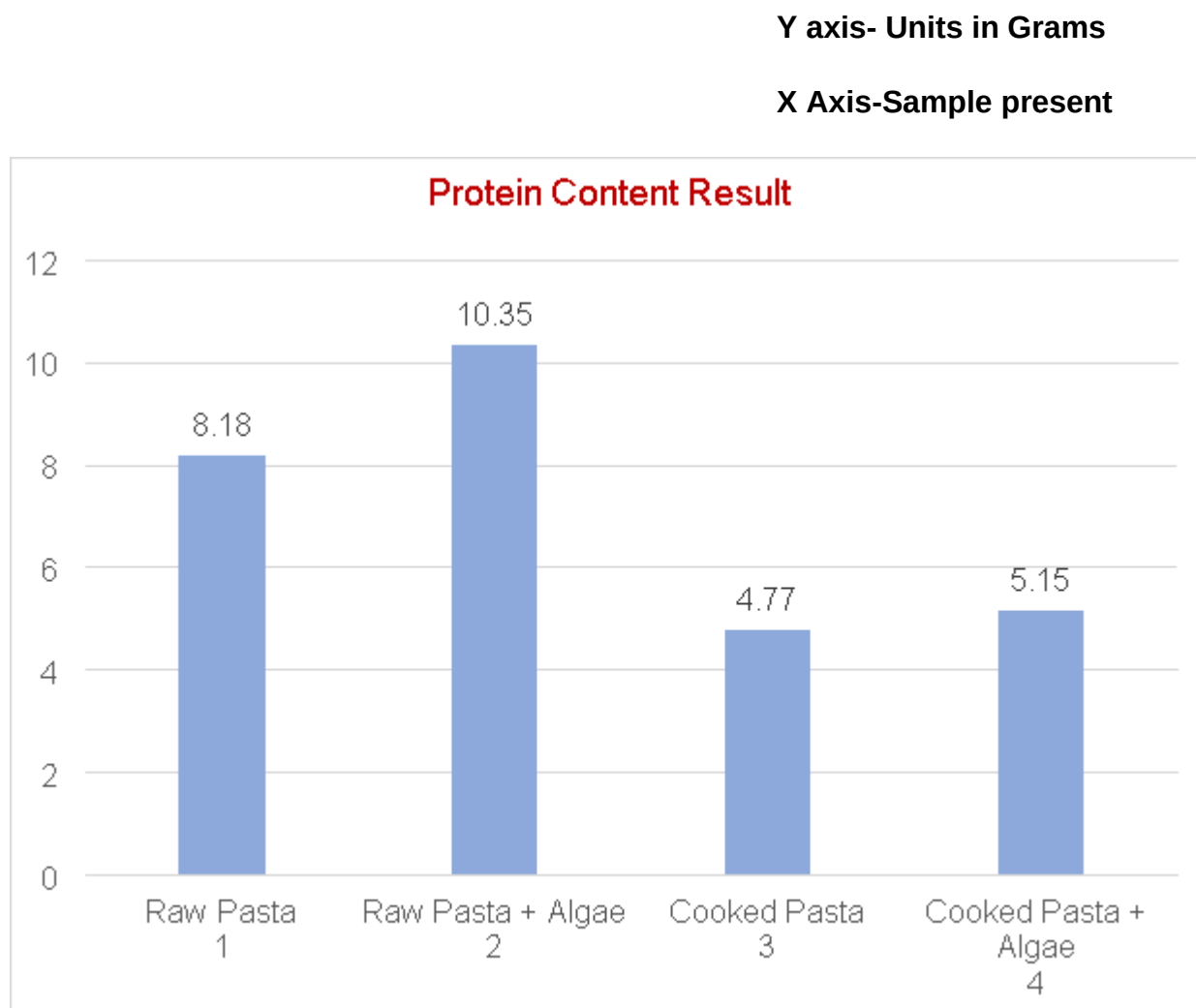
5.1 Protein

- Spirulina boasts a 60% protein content — it's a richer source of protein than most vegetables.
- It is considered a complete source of high-quality protein and is often compared to eggs for the amount of protein per gram.
- The protein in Spirulina is highly usable and has a net protein utilization rate of between 50-61%.
- Spirulina holds up to 70% of highly digestible proteins (94% of the absorption coefficient). This easy digestibility is especially important for people that suffer from intestinal malabsorption.
- The protein content is 2.5 times above that of lean meat. It contains all the essential amino acids or people who our body must take it from. Taken within a strict vegetarian diet, it provides lysine and methionine.
- To assess the possible, we report the protein content of varied foods:
 - – Eggs 13.3%
 - – Soybean 43.2%
 - – Grain 29.2%
 - – Peanuts 25.3%
 - – Spirulina 65%
- The comparison is certain that the Spirulina makes up the very best and most powerful source of digestible protein.

Table 5.1 Protein Content Results

NO.	SAMPLES	UNIT (GRAMS)	PROTEIN CONTENT
1.	Sample 1 - Raw Pasta	100	8.18g
2.	Sample 2 - Raw pasta + 3 % Algae	100	10.35g
3.	Sample 3 - Cooked pasta	100	4.77g
4.	Sample 4 - Cooked pasta + 3 % Algae	100	5.15g

5.1.2 Protein Content Chart



Graph 5.2 Protein content results

- The protein content in Sample 2 has been increased from 8.18 grams to 10.35 grams. This shows that algae pasta has high protein content and has kept increasing its whenever it gets incorporated with spirulina.
- Similarly, the sample 4 shows an increase in protein content due to the fortification of 3% spirulina algae.
- Protein content has increased when spirulina algae infused with pasta in both raw and cooked form that makes it functional food product.

- The samples under study present values of 10% of protein when pasta was fortified with algae comparatively to 8% of pasta without algae added.
- When cooked by the traditional method, the percentage of protein found was 5% for pasta with algae and 4% for cooked pasta without algae.

5.2 Carbohydrate

- Spirulina holds from 10 to 15% of carbohydrates in the form of polysaccharides. The key role of carbohydrates is to provide energy to the body.
- They supply about 50-70% of the total energy required by the body (1 g of carbohydrate provides 4 kcal of energy).
- Moreover, providing ready fuel, carbohydrates play an important role in maintaining the right functioning of the liver, central systema nervosum, heart and contraction.
- Due to its composition Spirulina may be a great source of quick energy for our body.

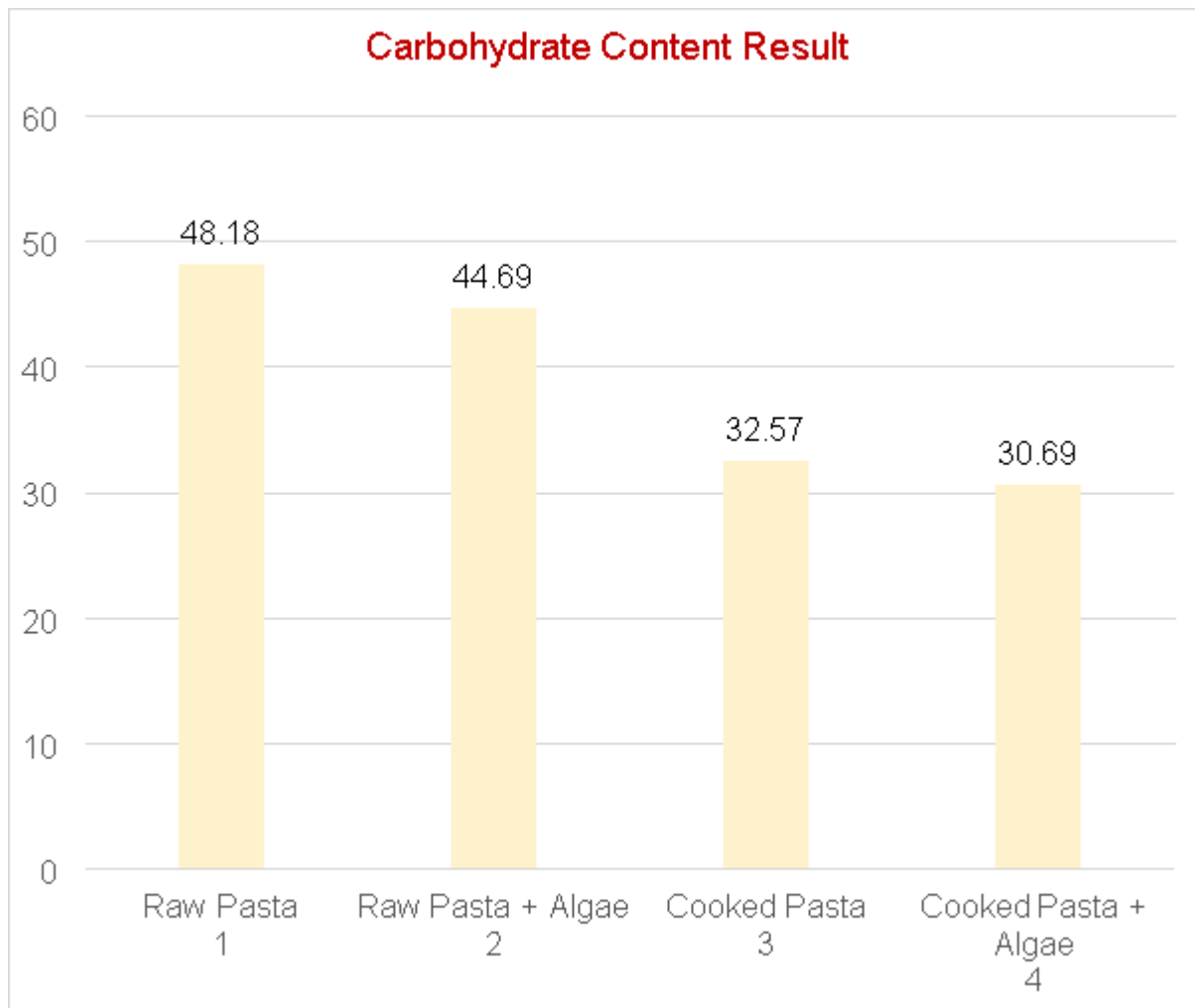
Table 5.3 Carbohydrate Content Results

No	SAMPLES	UNIT (GRAMS)	TOTAL CARBOHYDRATE CONTENT
1.	Sample 1 - Raw pasta	100	48.10g
2.	Sample 2 - Raw pasta + Algae	100	44.69g
3.	Sample 3 - Cooked pasta	100	32.57g
4.	Sample 4 - Cooked pasta + Algae	100	30.69g

5.2.2 Carbohydrate Content Chart

Y axis- Units in Grams

X axis-Sample's present



Graph 5.4 Carbohydrate content results

- The sample 2 which is raw pasta with algae has declined in the carbohydrate content as compared to that of sample 1 which is raw pasta.
- Similarly, the sample 4 which is cooked pasta with algae has decreased in its carbohydrate content from compared to sample 3 which is cooked pasta.
- Carbohydrate content has decreased when incorporated with spirulina algae due to the presence of high mineral content in spirulina.

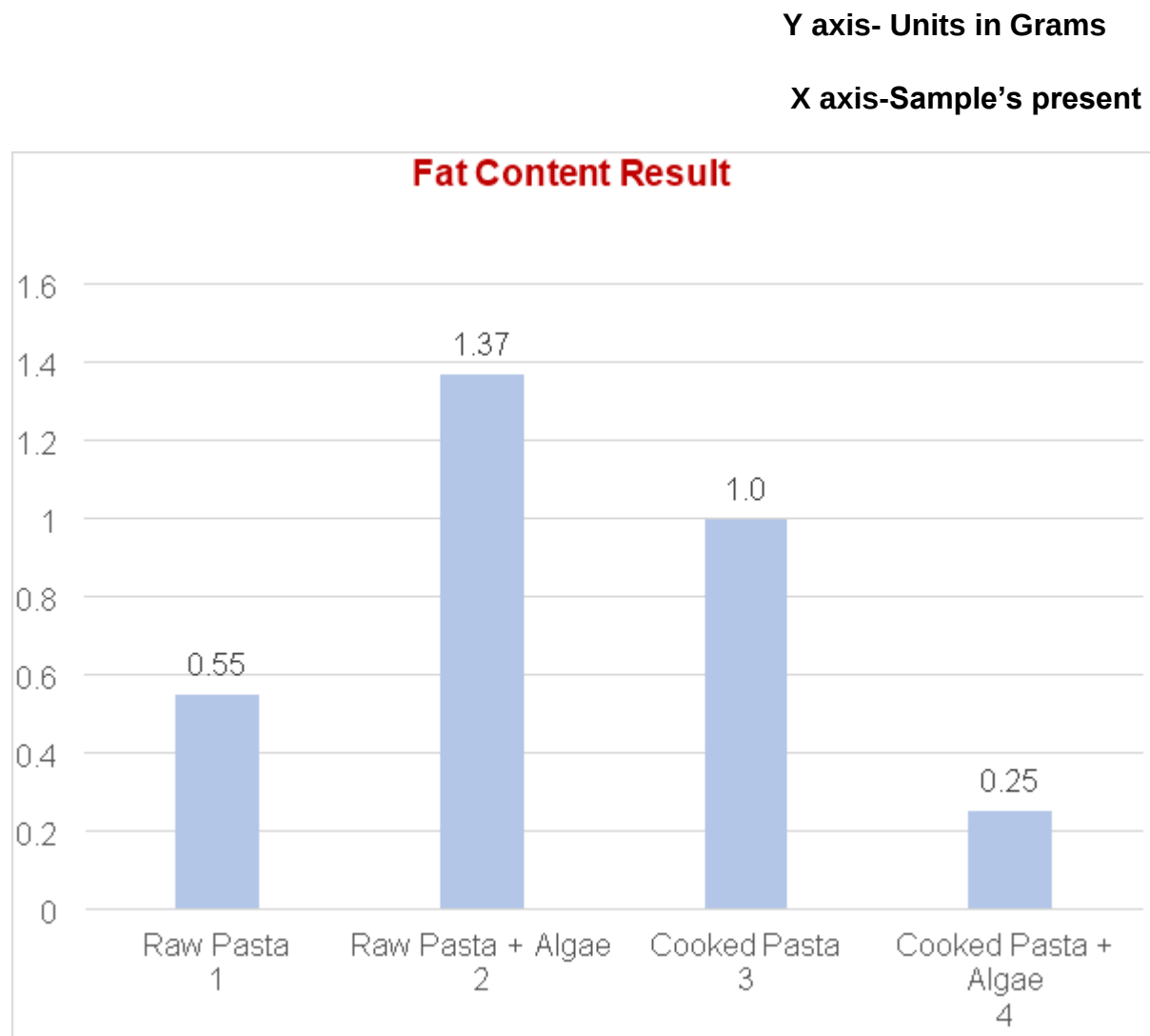
5.3 Fat

- The fats are soluble organic substances in solvents like alcohol, ether and chloroform, but insoluble in water.
- Humans are biological membranes of all cells; they're accumulated within the storage tissue as an energy reserve and are found within the blood stream into complex structures referred to as plasma lipoproteins.
- The most common sources of lipids are: milk, cheese, olive oil, walnuts, canola, soybean, flaxseed, salmon and mackerel.
- Lipids are the richest source of energy and humans it's immagazinata as a deposit so as to supply power if you'll not get from carbohydrates (1 g of fat provides 9 kcal of energy). A drastic reduction of the consumption of fats results in weight loss and weakness.
- Fat is important because:
 - function vehicles for the absorption of vitamins as A, D, E and K;
 - Help the right development within the growth;
 - Help within the formation of all cell membranes.
- Spirulina contains about 7% of lipids of many essential fatty acids. Among these the foremost significant are the linolic acid and gamma-linolenic acids which give the Spirulina the caratteristicha to normalize the cholesterol content within the blood.

Table 5.5 Fat Content Results

NO.	SAMPLES	UNIT (GRAMS)	FAT CONTENT
1.	Sample 1 - Raw pasta	100	0.55g
2.	Sample 2 - Raw pasta + 3% Algae	100	1.37g
3.	Sample 3 - Cooked pasta	100	1.0g
4.	Sample 4 - Cooked pasta + 3% Algae	100	0.25g

5.3.2 Fat Content chart



Graph 5.6 Fat content results

- Initially, the sample 1 of raw pasta has fat content 0.55, after its being fortified with 3 percent of spirulina, the fat percentage went straight up to 1.37 as its rich in essential fatty acids.
- According to sample 4, the fat content is less compared to sample 3 without the presence of algae.

- The dietary composition affected the fatty acid profile of wheat pasta. The addition of dried algae spirulina caused changes in fatty acids.
- The differences measured between the beginning and the end of the experiment showed that the more algae were added to the sample, the greater changes in the fatty acids profile were found.
- Fat extraction and fatty acids analysis conditions could probably cause a partial evaporation of highly volatile short chain fatty acids.

5.4 Moisture

- Moisture content in food impact its mass, taste, texture and appearance. For these basis, different materials have defined standards.
- Any difference from those could affect the standard and consistency of food items.
- Testing for moisture content is more important for meeting legal requirements in food labeling, setting up food's dry weight, determining yield and know when a drying process has finished.
- For producers and makers in both the food and agricultural industries, knowing the moisture content of products are important.

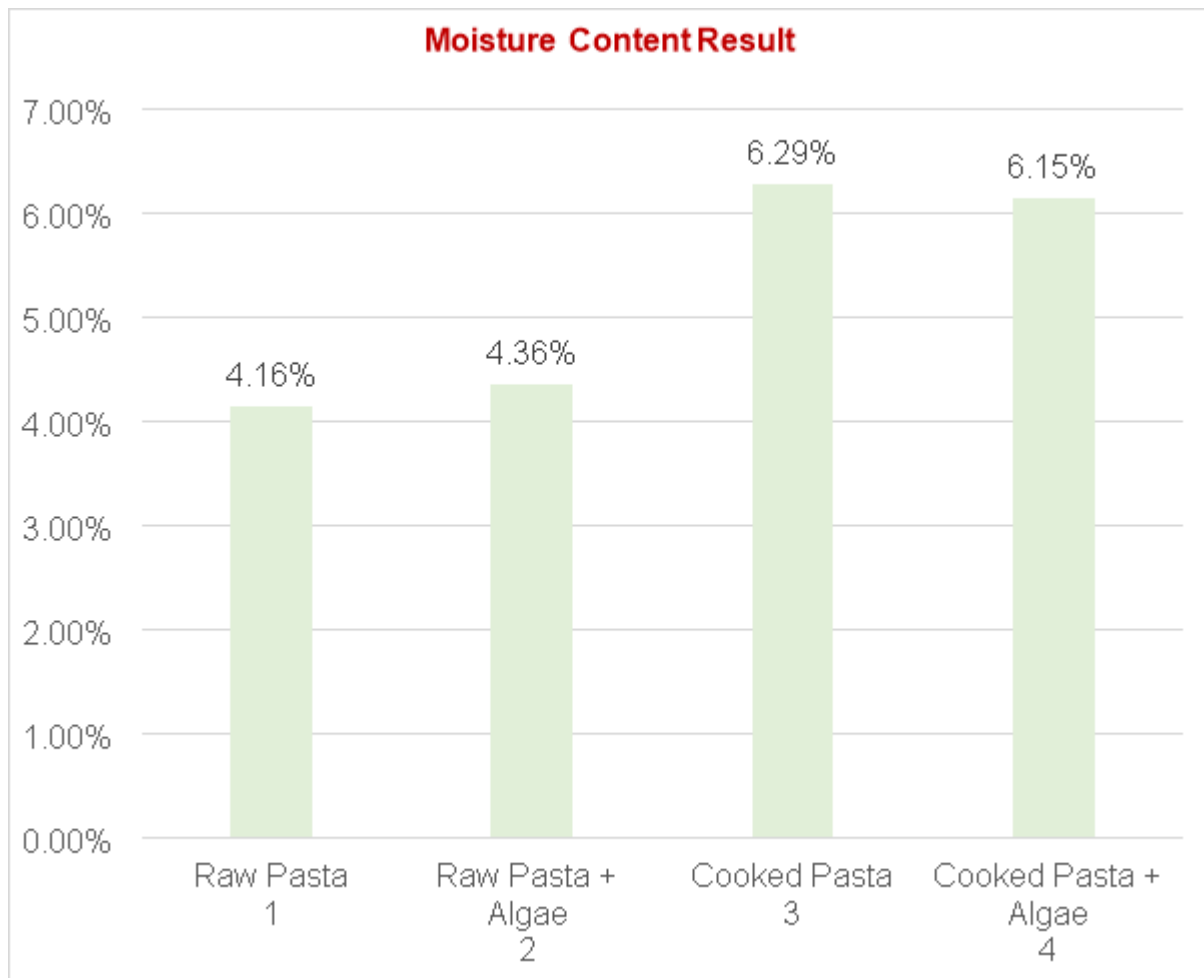
Table 5.7 Moisture content result

NO	SAMPLES	UNIT	MOISTURE CONTENT (RESULTS)
1.	Sample 1 – Raw pasta	%	4.16%
2.	Sample 2 – Raw pasta + 3% Algae	%	4.36%
3.	Sample 3 – Cooked pasta	%	6.29%
4.	Sample 4 – Cooked pasta + 3% Algae	%	6.15%

5.4.2 Moisture content chart

Y axis- Units in Percentage

X axis-Sample's present



Graph 5.8 Moisture content results

- According to the chart given above, the moisture content of sample 2 which contains Raw algae pasta has increased compare to that of sample 1 without added algae.
- Moreover, the moisture content of sample 4 has dropped when it's been for fortified with spirulina.
- For nutritional analysis pasta was freeze dried after it's been drained. The moisture content of cooked and drained pasta was 61% (pasta with algae) and 63% (pasta without algae added).

5.5 Ash

- Ash refers to the inorganic residue persist after either ignition or complete oxidation of organic matter in the course of a food sample.
- Determining the ash content of a food is a component of proximate analysis for nutritional evaluation and it's a crucial quality attribute for a few food ingredients. Also, ashing is that the initiative within the preparation of a sample for specific elemental analysis.
- This laboratory utilizes the dry ashing technique with a muffle furnace to formulate the ash content of a spread of food products.
- Moisture content determination is additionally included so ash content data are often expressed on both a wet weight basis and a dry weight basis.

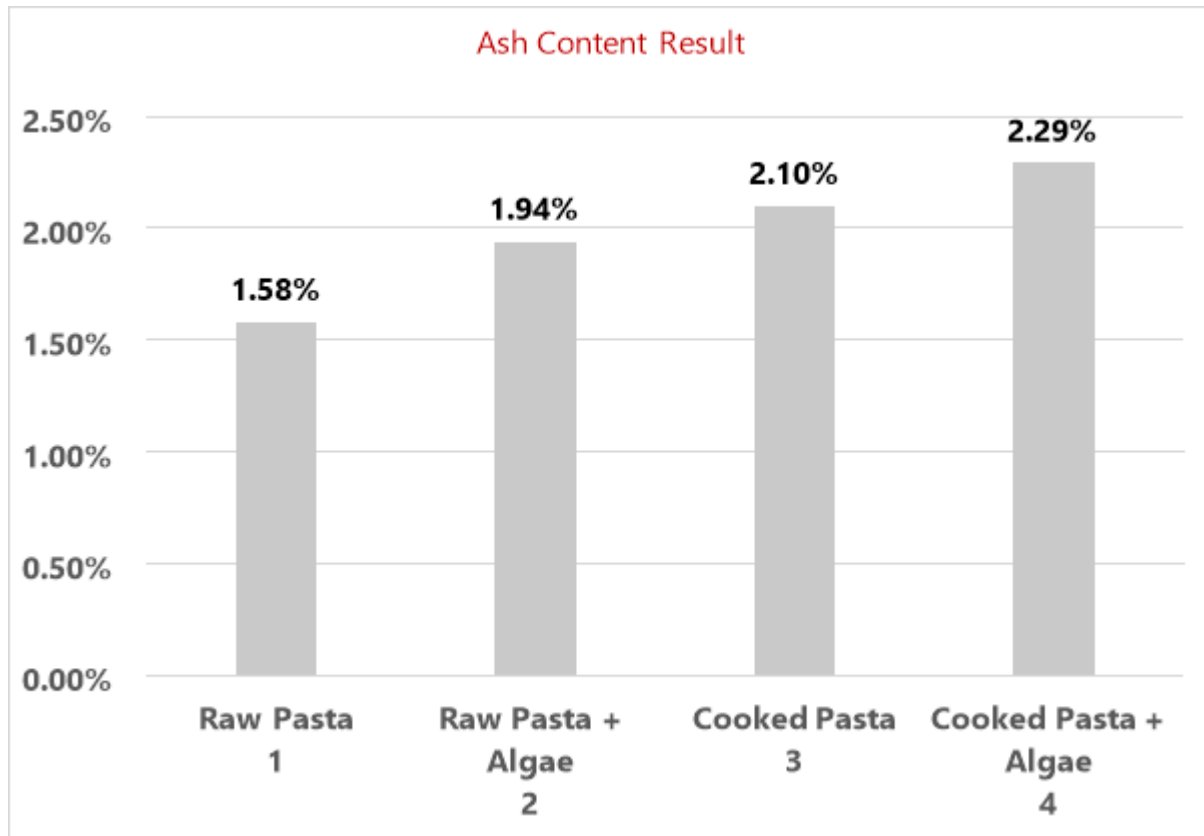
Table 5.9 Ash content result

NO.	SAMPLES	ASH CONTENT
1.	Sample 1 – Raw pasta	1.58%
2.	Sample 2 – Raw pasta + Algae	1.94%
3.	Sample 3 – Cooked pasta	2.10%
4.	Sample 4 – Cooked pasta + Algae	2.29%

5.5.2 Ash content chart

Y axis- Units in Percentage

X axis-Sample's present



Graph 5.10 Ash content result

The ash content of wheat pasta infused with algae which includes both raw and cooked has increased significantly.

5.6 Total nutritional analysis of regular and fortified pasta

- Micro algae such as spirulina are often examined as a substitute and favorable ingredient for food fortification or enrichment. Due to their nutritional composition, especially protein-high composition, they considered as a sustainable protein source for food.

- One of the groups that deserve special attention are the malnourished children, who may present variety of specific nutritional deficiencies that has got to be supplied by diet.
- Within this plot, the enrichment of pasta products with Spirulina becomes very fascinating, because it builds food a source of protein and carbohydrates, also as providing various dietary bioactive compounds, essential fats and vitamins.
- The children and elderly people have more chance of developing nutritional deficiencies of vitamins, minerals, and proteins also as energy.
- The addition of Powdered spirulina platensis to food is of interest because of the microalgae's nutritional content. Hence., this study seeks to develop fortified wheat pasta, enriched with Spirulina.
- Compared with the control sample, the fortified food product has a higher nutritional value.
- Compared to the control sample, humans accepted the fortified food in terms of taste and appearance.
- Foods enriched with spirulina are rich in Protein, lipids and carbohydrates and micronutrients which will be beneficial for the malnourished children and elderly people and other diseases caused.

Table 5.11 Total nutritional analysis of regular and fortified pasta

NO.	Test Parameter	Unit	Control Sample		3% Spirulina	
			Raw	Cooked	Raw	Cooked
1	Protein	g/100g	8.18g	4.77g	10.35g	5.15g
2	Carbohydrates	g/100g	48.1g	32.57g	44.69g	30.69g
3	Fats	g/100g	0.55g	1.0g	1.37g	0.25g
4	Moisture Content	%	4.16%	6.29%	4.36%	6.15%
5	Ash Content	%	1.58%	2.10%	1.94%	2.29%
6	Ph value	-	7.035%	7.035%	6.085%	6.085%
7	Alcoholic Acidity	%	0.13%	0.13%	0.17%	0.17%

5.7 Result discussions

- Current work shows that spirulina-rich foods made from spirulina can be accepted for sensory parameters, which are 3%, and the most acceptable foods found during storage are satisfactory within.
- The results show that the developed feed has no nutrients and its nutritional value is much higher than that of the control sample.
- Therefore, this valuable product has tremendous compression potential and is more sensitive to the senses.

- Therefore, improving the quality of spirulina-fortified foods provides consumers with significant benefits.
- After analysis, the nutritional components of wheat pasta (before and after cooking) are shown in Table 5.11. As expected, carbohydrate levels (including fiber) are very high in all samples tested.
- In this study, which constitutes a good source of energy for pasta. Both the paste and the ash content show a lower value. Due to the high mineral content of the algae, the whole algae scar has a higher ash content than the paste without algae.
- In addition to carbohydrates, pasta can be high in protein. At present, the protein content of pasta fortified with seaweed is 10% while the protein content of pasta without seaweed is 8% as shown in Table 5.1.
- When cooked in a traditional way, it was found that the protein percentage of algae pasta was 5%, and the protein percentage of algae-free pasta was 4%.
- The results show that when ingredients such as laver (3% spirulina) is added to pasta, the increase in protein may be due to the addition of spirulina, and these microalgae are good for protein source.

CHAPTER 6

SUMMARY

The main contributor to this review is to demonstrate that daily consumption of spirulina can significantly improve the nutritional capacity of children. The influence of this point of view shows that the mixture of spirulina and food has a powerful effect on the human body. The top linear increase in malnourished children. A distinctive feature of this method is the use of native microalgae. In terms of sustainability and acceptability, the use of local support is essential to improve the objectives. Additionally, spirulina's water and energy consumption is much lower than the consumption of various ingredients advertised with soy as a dietary supplement for The large amounts of water and moderate temperatures in India are best suited for growth, although spirulina production is also well suited for hot spirulina, although this vitamin fortification program can solve the problem of vitamins in the developing This is the purpose of adding spirulina as a dietary supplement to pasta, the purpose is to strengthen the product with foods enriched with protein, calcium, iron and phosphorus B12, and to improve the life expectancy of In addition, it has many medicinal properties, spirulina produces 20 times more protein than soy, and spirulina generally contains around 60% protein. This is a great contribution of vitamin B12, copper and iron to your diet. The protein energy of spirulina is very low. Spirulina contains 3 to 9 energy units per gram of protein, while spirulina protein contains 65 energy units. Protein in beef. The researchers specifically added spirulina to recipes for cookies, pasta and noodle products, and then evaluated its nutritional value under normal cleaning the results showed that the levels of protein, calcium and phosphorus improved significantly. Iron no longer produces many flavoured food substitutes. The microalgae paste has very attractive colours, such as orange and green, similar to vegetable pasta, and its nutritional properties have the same energy value as commercial pasta. The use of microalgal biomass can improve the nutritional and sensory qualities of pasta without affecting its cooking characteristics and texture. The results show that the developed feed has no nutrients and its nutritional value is much higher than that of the control sample. Therefore, this valuable product has tremendous compression potential and is more sensitive to the senses. Therefore, improving the quality of spirulina-fortified foods

provides consumers with significant benefits. After analysis, the nutritional components of wheat pasta (before and after cooking) As expected, carbohydrate levels (including fiber) are very high in all samples tested. In this study, which constitutes a good source of energy for pasta. Both the paste and the ash content show a lower value. Due to the high mineral content of the algae, the whole algae scar has a higher ash content than the paste without algae. In addition to carbohydrates, pasta can be high in protein. At present, the protein content of pasta fortified with seaweed is 10% while the protein content of pasta without seaweed is 8%. When cooked in a traditional way, it was found that the protein percentage of algae pasta was 5%, and the protein percentage of algae-free pasta was 4%. The results show that when ingredients such as laver (3% spirulina) is added to pasta, the increase in protein may be due to the addition of spirulina, and these microalgae are good for protein source. The food-based approach seeks to improve nutrition by increasing the supply and consumption of a diet rich in nutrients and micronutrients in a variety of available foods. Food-based methods are considered part of a broader strategy to eliminate iron and other trace minerals. Spirulina contains a special form of protein that can help combat Malnutrition and many other defects.

CONCLUSION

This Thesis shows that when functional ingredients (such as seaweed) is added, and the Protein, Carbohydrates, Fat's content of the pasta increases. Spirulina is a potential source of protein and other essential nutrients that can be turned into functional food by adding it to foods (such as pasta). It helps the algae-rich paste (spirulina) and the longevity tree to be richer in protein. As a result, by adding functional ingredient Algae (Spirulina) to Pasta the nutritional value is increased such as Protein, Carbohydrates, Fat, Iron, Calcium. Spirulina is a potential source of Protein, Fat, Calcium etc and thereby adding in foods like Pasta, it leads into functional foods (Fortified food). Recent work shows that foods fortified with 3% spirulina extracted from spirulina are acceptable in terms of sensory parameters and the most acceptable foods are within a satisfactory range during. As a result, this valuable product has enormous compression potential and increased sensory sensitivity. Therefore, using spirulina to fortify food with better quality parameters brings huge benefits to consumers and it helps to combat Malnutrition in children.

REFERENCES

- [1] Ali, S. & Saleh, A. Spirulina – an overview. International journal of Pharmacy and Pharmaceutical sciences. Vol 4, Issue 3, 2012. VIT University, Vellore, India, School of biosciences and technology.
- [2] Abd El-Hameed, M., Abou El-Maatti, S., El-Saidy, S. and Ahmed, S. EFFECT OF ADDING Spirulina platensis IN PASTA PRODUCTS (SPAGHETTI). *Zagazig Journal of Agricultural Research*, 45(1);2018;.293-300.
- [3] Birot, R., de Jouvencel, D., Raginel, L, G. From malnutrition to HIV: spirulina is an effective solution which continues to reveal its secrets. Field actions science report. The journal of field actions, special issue 5, 2012. Institute Veolia Environment.
- [4] Barsanti, L. & Gualtieri, P. 2006. Algae – anatomy, biochemistry and biotechnology; (2006).
- [5] Delrue, F., Alaux, E., Moudjaoui, L., Gaignard, C., Fleury, G., Perilhou, A., Richaud, P., Petitjean, M. & Sassi, J-F. Optimization of Arthrospira Platensis (Spirulina) growth, from laboratory Scale to Pilot scale. MDPI - Fermentation.2017.
- [6] Fathima, A.Homesciencejournal.com.
[www.homesciencejournal.com/archives/2017/vol3issue2/PartK/3-2-115-778](http://www.homesciencejournal.com/archives/2017/vol3issue2/PartK/3-2-115-778;);(2021)
[Read on 4 January 2021].
- [7] Grahl, S. Ediss.uni-goettingen.de.ediss.uni-goettingen.de/bitstream/handle/21;
2021. [Read on 4 January 2021].

- [8] Lemes A., Takeuchi, K., Carvalho, J. and Danesi, E. Fresh pasta production enriched with *Spirulina platensis* biomass. *Brazilian Archives of Biology and Technology*, 55(5); 2012; 741-750.
- [9] Marzieh Hosseini, S. *Spirulina paltensis: Food and its functions*. ResearchGate.www.researchgate.net/publication/262107454 *Spirulina paltensis* Food and Function; 2021 [Read on 4 January 2021].
- [10] Mahmoud, N.www.researchgate.net/publication/338208891 World Journal of Food Research Incorporation of *Spirulina Athrospira Platensis* in Traditional Egyptian Cookies as a Source of Natural Bioactive Molecules and Functional Ingredients Enhancing Nutrition [Read on January 2021].
- [11] Ozyurt, G., Uslu, L., Yuvka, I., Gokdogan, S., Atci, G., Ak, B. and Isik, O. Evaluation of the Cooking Quality Characteristics of Pasta Enriched with *Spirulina Platensis*. *Journal of Food Quality*, 38(4); 2015; 268-272.
- [12] Priyadarshini, I. & Rath, B. Commercial and industrial applications of microalgae – A review. *J. Algal Biomass Utln.* 2012, 3 (4): 89-100. Department of biotechnology, North Orissa University.
- [13] Ragusa, I., Nardone, G., Zanatta, S., Bertin, W. and Amadio, E. *Spirulina for Skin Care: A Bright Blue Future*; 2021.
- [14] Srilakshmi B. Food Science. New Age International Publishers, New Delhi, India, 2008.
- [15] Swaminathan MS, Food science chemistry and experimental food. The Bangalore Printing and Publishing Co. Ltd., Mysore Road, Bangalore (Karnataka) India. 1987.

[16] Wells, M., Potin, P., Craigie, J., Raven, J., Merchant, S., Helliwell, K., Smith, A., Camire, M. and Brawley, S. *Algae as nutritional and functional food sources: revisiting our understanding* (2021).

[17] Xue, C., Hu, Y., Saito, H., Zhang, Z., Li, Z., Cai, Y., Ou, C., Lin, H. and Imbs, A. Molecular species composition of glycolipids from *Spirulina platensis*. *Food Chemistry*, 77(1), 2002; pp.9-13.

