DEVELOPMENT OF VEGAN PROTEIN POWDER AND ITS QUALITY ANALYSIS

By

Nalasri. P

(20PFD019)

Thesis submitted to

Avinashilingam Institute for Home Science and Higher Education for Women

Coimbatore – 641043

In partial Fulfillment of the Requirements for the Degree of Master of Science in

FOOD SERVICE MANAGEMENT AND DIETETICS

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Certified as a Bonafide Research work

Signature of the Supervisor

Signature of the Head of the Department

ACKNOWLEDGEMENT

First and the foremost, the investigator would like to given her utmost gratitude to the **Almighty God** for the blessings and divine grace he has showered upon her for giving her the understanding, capacity, knowledge, good health and the ability to complete her study successfully within time.

The investigator pays her deepest gratitude to **(Late) Dr.T.S. Avinashilingam** Founder, and First Chancellor, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, for being a continuous source of motivation.

Reverential homage is paid to the Doyen of Nutrition Colonel and **(Late) Dr. (Mrs) Rajammal P. Devadas,** Former Chancellor, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, for being a perennial source of inspiration.

I express my sincere gratitude to **Dr.Thiyagarajan,** D.Sc, M.D, Ph.D., Chancellor, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, for providing an opportunity to conduct the study.

I owe deepest gratitude to **Dr. V. Bharathi Harishankar**, Vice Chancellor, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, for granting permission to carry out the study in the University.

I am very much indebted to **Dr. (Mrs) S. Kowsalya,** M.Sc., M.Phil., Ph.D., Registrar, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, for having extended all help for the smooth conduct of the study.

I am gratefully acknowledged heartfelt thanks to **Dr. (Mrs) N. Vasugi Raaja,** M.Sc., M. Phil, Ph.D., Dean school of Home Science, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, for providing opportunity to conduct a study smoothly.

I wish to express my profound sense of gratitude and sincere thanks to **Dr. (Mrs) S. Uma Mageshwari,** M.Sc., M. Phil., Ph.D., Dean of Student affairs, Professor, Former Head of the Department of Food Service Management and

Deitetics, Avinashilingam institute of home science and higher education for women, Coimbatore, for her concern, valuable comments and suggestions, sustained and unsurpassed encouragement throughout the completion of study.

I express my sincere thanks and gratitude to **Dr. (Mrs).V.Premala Priyadharsini,** M.Sc., M. Phil., Ph.D., Professor and Head of the department, Department of food Service Management and Dietetics, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore. Forher vital cooperation and help in ensuring the successful completion of my research.

I express sincere gratitude and reverence towards our beloved guide **Dr. (Mrs). R. Radha,** M.Sc., M.A (YHE)., M. Phil., Ph.D., Assistant Professor (SG),Department of Food Service Management and Dietetics, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore. Her way of guidance and encouragement helps us to complete successful research. Her sincerity, kindness, support and interests all together aids to shape the research and makes it more valuable. She truly inspired us by her action and enlighten us with her knowledge.

I would like to thank all the women selected subjects who spent their valuable time to complete my part of study which also explores their knowledge too.

I record my gratitude and love towards all my seniors for their unparalleled support and timely help to complete my study.

I am also grateful to my family for their prayers, mental & moral support, monetary support and kindness which are really essential for me to full fill the study.

And I finally thank everyone who extends their support directly or indirectly throughout the completion of the study.

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I. INTRODUCTION

Every human being is the author of his own health and disease

- Buddha

According to WHO “Health is a state of complete physical, mental and social well-being of the person. Now-a days the term health has 3 types of definitions. The first definition is health is the absence of disease and impairment. The second health defines the state which allows individuals to sufficiently cope with all demands. The third health defines the state of balance in his social and physical environment. (Sartorius, 2006).

The healthy lifestyle of a person is defined by healthy eating, regular exercise, proper sleep, and protection of the body from harmful substances. Following a healthy lifestyle is necessary Obesity, cancer, diabetes, high blood pressure, Cardio Vascular Disease, and premature death are all chronic illnesses that can be prevented (Aliand Kamraju, 2017).

It is alarming to note that the essential element for good health is Nutrition. Malnutrition in people results in improper muscle function, anemia, slow wound healing, and decrease bone strength. (Ahmed and Haboubi,2010). To avoid malnutrition aiming to ensure sufficient consumption of macronutrients and micronutrients (Savarino *et al*., 2021).

Savarino *et al*., (2021) stated that macronutrients are consumed in large quantities including CHO, Protein, and fats on the other hand micronutrients are consumed in small quantities including vitamins and minerals. The deficiency of macro and micronutrients has a crucial influence on the whole human body function and physiology of the body.

According to the ICMR Guidelines, the protein recommendation for 1-6 months infants is 1.16g/kg/day to increase in weight, height, and head circumference of the baby, and the protein recommendation for 6 - 12 months children is 1.69g/kg/day. The weaning should be loaded with adequate micronutrients including calcium, phosphorous, and vitamin D. These micronutrients are necessary for proper bone growth (Sharma, 2020).

The recommended dietary allowances for boys aged 10-12 years are Energy 2190kcal/d, Protein 39.9g/kg/day, for boys aged 13-15 years Energy 2750kcal/d, Protein 54.3/kg/day, for boys aged 16-17 years Energy 3020kcal/d, Protein 61.5/kg/day (Sharma, 2020).

The recommended dietary allowances for girls aged 10-12 years are Energy 2010kcal/d, Protein 40.4 g/kg/d, for girls aged 13-15 years Energy 2330kcal/d, Protein 51.9 g/kg/d, for girls aged 16-17 years 2440 kcal/d, Protein 55.5g/kg/d (Sharma, 2020).

The recommended dietary allowances for Indians according to ICMR guidelines For Men 2320 to 3490 kcal/day, protein 60g/kg/day, and for women 1900-2850 kcal/day, Pregnant women +350 kcal/day and lactating women +600kcal/day, Protein 55g/kg/day, Pregnant women 78/kg/day, Lactating women 68-74g/kg/day, Calcium 600mg/d, Pregnant and lactating women 1200mg/d, Iron 21mg/d, pregnant women 35mg/d, Lactating women 21mg/d (Sharma, 2020).

Food and Agricultural Administration concluded that a global shortage of protein-rich foods is reported in 2020 due to Covid and ultimately it affects the consumption of protein-rich foods worldwide. It results in less consumption of protein worldwide (Gakpo,2020).

Insufficient protein intake causes protein deficiency in people.Jelliffe proposed the term “Protein-Calorie Malnutrition and it was adopted by the Food and Agricultural Organization and World Health Organization in the year 1961 (semba,2016). Protein deficiency can cause various diseases kwashiorkor (delayed growth and bloated bellies in children), edema (swollen and puffy skin), liver failure, skin, hair, and nail problems, and muscle wasting in cancer patients. (Muller 2005)

It is alarming to note that if protein deficiency is left untreated it may cause death in people. If the pregnant woman is suffering from protein deficiency it will usually affect the baby. It is important to note that pregnant women should take adequate protein for a healthy pregnancy and healthy baby. (Semba 2016)

Khandelwal *et al.,* (2018) reported that Protein deficiency during pregnancy affects birth weight, placental weight, premature birth, and increasing head

circumference at birth among undernourished women even after adjusting maternal age and parity. Malnutrition is diagnosed by using anthropometric measurements and physical examination.

Dietary protein is considered the essential macronutrient for the growth and development of lean body mass. Adequate protein helps to strengthen and maintain muscle mass specifically in adults and active people, gain weight and prevent muscle wasting in chronic conditions. (Lonnie *et al*., 2018) The protein intake is related to decreased urinary nitrogen excretion. It plays an important role in preventing Protein Energy Malnutrition (Burd*et al*., 2019).

A study done by Mariotti (2019) reported that vegan protein promotes major health benefits among adults and older adults. Animal proteins are linked to an increased risk of heart disease and diabetes. In contrast, plant food provides high protein and low fat it resulting in preventing obesity, diabetes, high blood pressure, and cardiovascular disease among adults and older adults. Plant protein reduces the CVD mortality rate compared with animal protein.

According to Hertzler*et al*. (2020), producing 1 kg of high-quality animal protein necessitated feeding 6 kg of plant protein to animals, posing a threat to land and water resources as well as potential increases in greenhouse gas emissions associated with livestock farming. Plant proteins can help provide enough high-quality protein for the population while also reducing the risk of negative environmental consequences if they are used more widely and wisely in the diet.

Hertzler*et al*.,(2020) reported that people who eat plant protein instead of animal protein have a lower body fat percentage, a lower BMI, and better heart health. Vegan protein is in high demand, and it is predicted to grow significantly over the next decade. Also, many health-conscious people are giving up meat and poultry, thereby changing over to the vegan diet, so with this in mind, it was decided to develop a vegan protein powder.

People are specializing in the ability of protein in everyday diet over the last ten years. From protein bars and powders to additives in vegan or vegetarian cuisine, people are focusing on the ability of protein in their everyday diet (Krefting 2017).

The powder was evolved by using different ingredients which are available at the household level. Ingredients used in vegan protein powder are pulses and legumes including Green gram dhal, peas, Black gram dhal, and Soyabean. The developed powder is high in energy, protein, and CHO.

Blazos*et al*., (2016) stated that Legumes and pulses are inexpensive food staple which has higher protein, other nutrients, and phytochemical content that helps for good human health. The major pros of legumes and pulses are they can also be affordable for poor people.

Legumes can be included in the diet in several ways such as tofu (Japan, China), bean sprouts(china, Korea), Chilli and refried kidney beans(Mexico), Dhal and papadums (India), falafel, and hummus (Middle east), Navy bean soup(Mediterranean), tempeh(Indonesia), pea soup (Sweden), Baked beans and Peanut butter(IUS, Australia) (Blazos*et al*., 2016).

Legumes are an excellent source of resistant starch which resists digestion in the small intestine and acts like a fiber in the large intestine. Resistant starch foods that are low in the glycaemic index help to control the blood glucose level and prevent fluctuations in glucose control (Garg and Dalal, 2020) (Polak*et al*., 2015).

A study was done by Polak*et al*., (2015) concluded that people with heart diseases can replace 2 servings of meat with legumes and have shown improvement in triglycerides, and LDL cholesterol levels.

Polak*et al*., (2015) also stated that legumes are a good source of potassium, magnesium, fiber, and also other nutrients which help in the management of blood pressure. Consuming legumes frequently results in decreased systolic and diastolic blood pressure.

Pulses are a good source of macronutrients including Proteins, and carbs, low in calories and fat content, Low GI food, and pulses are gluten-free sources. Along with the macronutrient present in pulses, some non-nutritional compound plays a major role in promoting health benefits (Polak*et al.*, 2015).

The bioactive components in pulses such as fiber, resistant starch, and bioactive phytochemicals make the pulses suitable to use in various ranges of health products. It helps to prevent many diseases and also pulses include bioactive chemicals that play a key role in physiological and metabolic processes. They can also be utilized to increase the functional characteristics of functional foods (Singh *et al*., 2017).

Singh *et al*., (2017) highlighted that, pulses have various biological properties such as antioxidant, anti-inflammatory, anti-atherogenic, and antimicrobial effects and pulses provide various bioactive compounds such as polyphenols, phytosterols, and oligosaccharides.

The phytochemical composition of some pulses including common beans, lentils, chickpeas, peas, etc., has been estimated based on their content of antioxidant compounds (Ciudad Mulero*et al.*, 2020).

Sudhakaran and Bukkan (2021) stated that Green gram dhal is imbued with essential amino acids such as phenylalanine, leucine, isoleucine, valine, lysine, arginine, prebiotic, nutraceutical properties, and also contains a good source of Riboflavin which is essential for pregnant women. Green gram dhal increases the protein content in the diet without increasing the fat content and also it can be taken as the meat exchange for vegans. It helps to build up the growth of beneficial microbiota in the gut and helps to carry through the probiotic bacteria to the gut.

Green peas are high in lysine thisaids in the improvement of immune system function and also helps to convert the fatty acid into energy. It is also an excellent source of non-heme iron and absorbs when combined with vitamin c. Pea protein isolates are a good source for renal patients (Krefting, 2017).

Black gram is high in protein, fiber, B vitamins, potassium, calcium, iron, Niacin, thiamine, and riboflavin. It aids weight gain, increases immune power, and strengthens muscle fiber. Black grams are highly recommended to take to those who are suffering from asthma, paralysis, and constipation (Rettu, and Kaur, 2021).

Singh, (2021) concluded that in women black gram intake helps to improve the hormonal imbalance, and proper function of the reproductive system, during

menstruation it prevents dysmenorrhea and increases milk production in lactating mothers. The iron content in black gram dhal increases the red blood cells and thus eases the supply of oxygen all over the body.

Friedman and Brandon (2001) stated that Soy protein is an important component of the diet, it has a higher amount of lysine compared to wheat proteins. It can be used in different forms such as infant formulas, flour, protein isolates, concentrates, and textured fiber.

Soy is also used as a meat substitute. The consumption of soy foods is being increased because of their high nutritional and health benefits. The health benefits of soy protein include the reduction of cholesterol levels, helping to prevent cancer, obesity, and diabetes, and protection from kidney disease (Friedman and Brandon, 2001).

Vega (2010) concluded that the non -nutritive health-boosting mixture of Phytochemicals manifests antioxidant activity and also it protects the DNA from damage and the galactooligosaccharides in pulses may obtain prebiotic activity and lower the risk of degenerative disease.

A study stated that humans who consumed plant-based diets frequently account for the reduction of metabolic syndrome development prevalence and daily consumption of pulses reduces the blood pressure, LDL cholesterol level protects against cancer, and improve the serum lipid profile (Mudryj*et al*., 2014).

Joshi *et al.,* (2019) concluded that both quantity and quality criteria can be met with plant proteins. This study reported that consuming approximately 1g of protein/kg/day in healthy people and protein intake of 0.7 to 0.9 g/kg/d in kidney patients doesn't cause any negative effects. It is alarming to note that the intake of vegan protein in a well-balanced diet is both nutritionally adequate and possesses pleiotropic effects, which may promote their usage in kidney patients.

Lactose malabsorption (LM) is the result of incomplete lactose breakdown because of a hereditary condition, which can develop as the main problem or as a complication of other gastrointestinal illnesses. Plant-based proteins act as a better substitute for those who are intolerant to dairy proteins (Satta*et al*., 2012).

In this study, Singh *et al*., (2017) reported that using pulses instead of energy-dense foods has shown many beneficial effects not only on the management but prevention of chronic diseases and other disorders.

McCracken and shah (2017) mentioned that meats and other animal fats, refined grains, and sweetened beverages result in high blood glucose levels. Plant-based diets help to control the blood glucose level and prevent type 2 diabetes helping to prevent the macro and microvascular complications of diabetes.

Plant lectins are a group of proteins and glycoproteins which is responsible to protect the body against cancer and the phytonutrient content of plant protein have shown improvement in diabetic patient (Madigan and Karhu, 2018).

Plant-based diets help to prevent the macro and microvascular complications of diabetes. A plant-based diet includes pulses, legumes, whole grains, nuts, and seeds and eliminates all animal products (McCracken and shah 2017).

Protein is essential to build muscles, build strength, repair tissues and muscles, proper digestion and metabolism, and brain functioning, also it helps to repair the damaged cells as well as produce new cells (Addison, 2020).

The plant protein takes a longer time to digest in the meantime the body begins to burn the extra fat, which helps to lose weight and manage the ideal body weight. Plant protein is the best source of food to treat metabolic syndrome (Adisson, 2020).

Hertzler (2020) proved that the Antinutrient content in plant protein also have potential benefit on human health such as cutting back blood sugar and/or plasma cholesterol and triglycerides and it has anti-cancer property.

Addison (2020) conveyed that the vegan protein powder helps the proper digestive system function, enhance digestion, and absorption of nutrient, and decrease the symptoms of indigestion and flatulence.

It is alarming to note that many people believe that only the animal sources are complete protein but the fact is Soy, tempeh, and peas are the complete sources of

protein. They can be included in the daily diet and there are also many ways to add vegan protein to a meal (Addison 2020).

Due to the several advantages of vegan protein powder, the powder can be incorporated into breakfast, dinner, snacks and beverages, Breakfast recipes like puttu, and dosa, Dinners like chapati, Snacks like nutritious balls, and beverages like coconut milk and pomegranate milkshake.

The advent of the information age coupled with the recent pandemic has made the general public conscious and aware of the need to be healthy more than ever. This is driving them towards a healthier, nutritious diet to keep them healthy and avoid going to hospitals. Furthermore, people who are ultra-conscious of diet and indulge in physical workouts partake in protein powders and various other health drinks.

By considering the above facts the study was conducted with the following objectives

1. To formulate vegan protein powder using selected pulses and legumes
2. To analyze the nutritive value, shelf life and microbial load of the isolated protein powder.
3. To create awareness on vegan protein to the selected subjects

II. REVIEW OF LITERATURE

The review of literature of the study titled **"Development of Vegan Instant Protein Powder and its Quality Analysis"** is presented under the following headings

A. Prevalence of Protein deficiency
B. Nutrient content and therapeutic properties of pulses and legumes
C. Effect of plant proteins on health and physical function
D. Existing vegan protein powders

I. PREVALENCE OF PROTEIN DEFICIENCY

Jelliffeintroduced the term "protein-calorie malnutrition," which came into frequent use and was officially adopted by FAO and WHO. In 1952, the Joint FAO/WHO Expert Committee on Nutrition held its third conference within the Gambia, with the meeting dedicated to malnutrition in mothers, infants, and kids, where the term "protein malnutrition" was introduced. According to WHO "Malnutrition defines that the excess or imbalance of nutrients in food" which results in poor body functions (Semba, 2016).

The protein-rich foods are foods with high content of protein including Pulses, Legumes and animal foods (Banovic,2018). According to Food and Agricultural Organization (FAO), a global shortage of protein-rich foods is predicted in the year 2020 because of COVID-19 and other factors. The anticipated decreased availability of protein products is anticipated to end in less consumption worldwide, specifically among the poor, which could aggravate health problems among children (Gakpo, 2020).

According to the study done by Krishnan *et al.,* (2012) stated that the prevalence of malnutrition increased in girls. The prevalence of PEM was moderate (46.3%) in 13-15 years age group girls, Severe (35.9%) in 11-13 years age group girls. On the other-hand girls in the age group of 17-19 years were highly suffered from Anemia rather than Malnutrition.

Missiriya (2013) conducted a study on the prevalence of protein deficiency among children in the slums of North Chennai. In his study, he stated that UNICEF (2008) reported 50% of children were died in India because of Malnutrition and also

National Family Health Survey reported 40% of children were underweight in India, 30% of children were malnourished in Tamil Nadu.

The protein-energy malnutrition study was conducted with 1501 pre-school children in the age group of 3-5 years. In the number of 1501 pre-school children, 44.4 % were children in the age of 3 years, 34.9% were children in the age of 4 years, 20.7 % were children in the age of 5 years. Overall 53.8% were boys and 46.2% were girls. The study resulted that the prevalence of underweight and malnutrition increased in 3 years compared to 4 years and 5 years children. (Patil and Divyarani, 2015)

Crichton *et al.,* (2019) conducted a study on Protein Energy Malnutrition with 69,702 people over the age of 65 years from 38 countries. The prevalence of protein deficiency ranged from 0.8% were suffered by malnutrition in Northern Europe, 24.6% of people were suffered by malnutrition in South- East Asia. The prevalence of protein deficiency was higher in rural communities compared to international rural communities and females had a higher prevalence than males.

Kushwaha *et al.,* (2020) conducted a study on adults over the age of 60, the prevalence of protein deficiency in India (clinic 28.87%, Orphanage 26.61%and community 16.27%) is higher than in Europe (Clinic 28.0%, Orphanage 17.5%, Community 8.5%). The reason behind protein deficiency in older people might be many diseases that in old age people were associated with protein Energy Malnutrition.

A survey done by Suri (2020) highlights that 73 % of Indians are suffering from protein deficiency while above 90% are unknowing of the daily protein requirement. A current survey over 16 cities in India on perception, knowledge, and consumption of protein found a recess within the knowledge of quality protein in daily diets.

Gakpo (2020) stated that protein is a vital part of a basic diet, but an estimated one billion people worldwide suffer from protein deficiency. the matter is most critical in the Central African Republic and South Asia, where about 30 per cent of youngsters consume insufficient protein.

According to the study done by Suri, in 2020, to guard the community against the impact of the pandemic, the govt. had announced a further Rs. 22.6 billion relief packages under the Garib Kalyan Yojana, which allows for an extra supply of 5 kg rice or wheat and 1 kg of pulses per month. Nevertheless, the application is proving to be ineffective particularly when it involves reaching resolute the beneficiaries.

There is an urgent must to spread awareness on what to eat, what proportion to eat, the significance of macronutrients, and also the varieties of easily available sources of protein. (Suri,2020). As a policy, the Public Distribution System (PDS) should provide protein-rich foods at subsidized rates to form them cheaper and available. States including Andhra Pradesh and Telangana providing pulses through PDS have better protein intake by households (Maphosa *et.al*, 2017).

According to Muller(2005) Poverty is the main underlying explanation for malnutrition and its determinants. The standard and distribution of protein-energy malnutrition and micronutrient deficiencies in a very specified population depend on several factors:

The situation political and economic, The extent of education and sanitation, The season and climate conditions, Food production, Cultural and non-secular food customs, Breastfeeding habits , The prevalence of infectious diseases, The existence and efficacy of nutrition programs and also the accessibility and quality of health services, Malnutrition is diagnosed by using anthropometric measurements and physical examination (Muller,2005)

A study done by Muller (2005) stated that malnutrition elevates one's vulnerability and severity of infections and is thus a serious component of illness and death caused by disease. Malnutrition is consequently the foremost major risk factor for the burden of disease in developing countries.

An enduring high or low consumption of protein results in an overall increase or decrease in the rate of aminoalkanoic acid catabolism that's partially independent of circulating organic compound concentrations (Butta and Sadiq, 2012). However the

most reason behind protein deficiency could be a protein-deficient diet, the disorder can commonly occur in a very kind of pathologic state (Dewraj,2015).

A study was done by Butta, Sadiq (2012) and Dewraj (2015) highlights that the dietary treatment of protein deficiency depends on the explanation for the deficiency and must rely upon a sound understanding of the underlying disorder and also the mainstay of treatment includes balanced energy-protein and micronutrient.

According to the study done by Semba (2016), the affected children were between the ages of 6 months and 4 years, often being breastfed by a malnourished or pregnant mother, and being weaned only on maize porridge. The foremost effective treatment was a mix of cod-liver oil and milk.

Williams stated that "Breast milk is maybe deficient in some factors, which are nowadays uncertain. As maize was the sole source of the supplementary food, some aminoalkanoic acid or protein deficiency can't be excluded as a cause (Semba, 2016).

It is alarming to note that many children with acute protein-energy malnutrition have asymptomatic infections since their system fails to reply with chemotaxis, opsonization, and phagocytosis of bacteria, viruses, and fungi. So that the body cannot protect against even from the fever that's typical of inflammation. (Muller,2005)

Proteins aren't only lacking within the Indian diet, but are often overlooked. India's protein consumption is far not up to the 48 gms/day that's recommended by the Indian Council of Medical Research (ICMR). The recommended dietary allowance of protein for a mean Indian adult is 0.8 to 1 gm per kg weight (Suri,2020).

It's alarming to note that protein deficiency causes several diseases, like kwashiorkor, which causes delayed growth and bloated bellies in children; edema, which causes swollen and puffy skin; liver disease, which could end in liver failure (Gakpo,2020).

The risk factors of Protein deficiency included skin, hair, nail, and muscle problems, poor wound healing, increased seriousness of infections, a weakened

system, high risk of bone fracture, and stunted growth, which affects over 160 million children annually (Muller,2005).

Muller (2005) stated in his study that it's the direct explanation for about 300,000 deaths each year and is accidentally chargeable for about half all deaths in young children the chance of death is directly correlated with the degree of malnutrition.

A review done by Suri (2020) stated that the importance of protein intake during the primary thousand days from conception to 2 years of age has lifelong implications.25% of this important stage is spent in utero. Children require both good quality and quantity of proteins to develop within the pre-natal and post-natal stages.

A Cochrane review done in 2015 proves that the nutritional education to accelerate energy and protein intake among expecting mothers, appears to be achieved in reducing the chance of premature birth, low birth weight, increasing head circumference at birth, and increasing birth weight among undernourished women (Khandelwal *et al.*,2018).

The World Health Organization evaluates that the requirement for protein within the trimester of pregnancy is notably higher 31g or more than in previous stages. There's a link between the composition of the mother's diet and therefore the birth outcomes. Intake of a high percentage of energy from the protein in early pregnancy is positively and remarkably related to birth weight and placental weight, even after adjusting for several confounders like maternal age and parity (Khandelwal *et al.*,2018).

II. NUTRIENTCONTENT AND THERAPEUTIC PROPERTIES OF PULSES AND LEGUMES

The Food and Agriculture Organization (FAO) defines the term "pulses" as edible seeds of members of the Leguminosae family. There are some pulses and FAO recognizes beans, broad beans, peas, chickpeas, cowpeas, pigeon peas, lentils, and other "minor" pulses. Nevertheless, beans, peas, lentils, and chickpeas are amongst the foremost commonly known and often consumed pulses worldwide and are so for a protracted time (Ferreira *et al.*,2021).

Pulses are annually grown leguminous crops that yield 1 to 12 grains/seeds within a pod and are often promoted in diet due to their low cost and lots of beneficial nutritional effects. Pulses are rich in macronutrients like proteins (usually 21-26 %), carbohydrates and are low in calories and fat (Singh, 2017).

In addition to a big source of vitamins and minerals, like iron, zinc, folate, and magnesium, consuming half a cup of beans or peas per day can increase diet quality by high intakes of those nutrients (Mudryj*et al.*,2014).

Protein inhibitors (PI) of hydrolases existing in pulses are functioning against factors that include proteases, amylases, lipases, glycosidases, and phosphatases. From the nutritional aspect, the inhibitors of the proteases, trypsin, and chymotrypsin are the foremost important Common beans (Phaseolus vulgaris) are the second largest group of seeds after cereals recorded as natural sources of α-amylase inhibitors (Singh *et al.*,2017).

In common beans, lima bean, cowpea, and lentil, protease inhibitors are characterized as members of the Bowman-Birk family. PI content in kidney beans is moderate and cowpea (8 and 10.6 g of trypsin and 9.2 g of chymotrypsin inhibited per kg, respectively), and low in lupin seeds (1.1 g of trypsin and 1.4 g of chymotrypsin inhibited per kg) (Singh *et al.*,2017).

It is important to require under consideration that pulses aren't generally consumed raw, but they need to be processed before consumption to enhance their nutritional quality and their palatability. (Mulero*et al.*,2020) Hence, the effect of various technological and warmth treatments such as germination, cooking, boiling, dehydrating, roasting, extrusion on the antioxidant compounds present in pulses has been also discussed. (Garg *et al.*,2020).

During this regard, it's been observed that as an outcome of processing, the phytochemicals content with antioxidant properties from time to time decreased, on the other hand, pulses that have undergone processing maintain relevant amounts of those compounds, maintain their beneficial health effect. (Mulero*et, al.*, 2020).

The phytochemicals, saponins, and tannins present in pulses possess antioxidant and anti-carcinogenic effects, specifying that pulses may have significant anti-cancer effects (Mudryj*et al.*,2014).

Pulses contain a considerable amount of bioactive compounds with health-promoting activities that play a crucial role in both physiological and metabolic processes and also make them useful for the development of functional foods that would be included within the daily human diet (Singh *et al.*, 2017).

Pulses are referred to as low GI foods. GI is the rating system for CHO foods. Low Glycemic index foods could improve the various physical functions in healthy adults and diseased individuals (Rizkalla*et al.*, 2002).

Pulses have several qualities to enhance glycaemic indexes like the low release of carbohydrates and high content of dietary fibre and protein. Pulses are the major source of dietary flavonols and are utilized in preparing flavonol-rich foods. when compared to other pulses higher amounts of oligosaccharides are present in Beans and peas (Polak*et al.*, 2015).

Yellow peas contain a high amount of arginine which helps to repair the muscles by support in the production of muscle-building creatine (Krefting,2017). Peas contain a high amount of lysine, the predecessor to carnitine that helps to convert fatty acid into energy (Shukla *et al.*, 2017).

Pulses have a high content of the essential organic compound lysine which is commonly found in low levels in cereal grains, thus, consumers following plant-based diets may let down in meeting lysine needs if pulses don’t seem to be included in their eating habits (Ferreira,2021).

According to the study done by Singh *et al.*, (2017) Lectins or haemag-glutinins are existed in many plant foods. Grain legumes are the most source of lectins in human food. Beans can be an important source of lectins. These antinutritional effects are possibly caused by a few lectins which will impair the integrity of the intestinal epithelium and it modify the absorption and utilization of nutrients. Lectin may be completely far away from lentil flour after 72-hour fermentation (42˚C) with a flour concentration of 79 g.

Singh *et al.,* (2017) stated that kidney beans have a high level of lectins and a low amount of lectins present in cowpea and lupin seeds. Lectins influence the response against ovalbumin and will promote the event of allergic reaction to plants containing lectins. Lectin is one of the main proteins which is present in lentils.

Singh *et al.,* (2017) stated that lectins can decrease nutrient absorption, but it has little effect after cooking. Phytic acid can decrease the bioavailability of the mineral it may result in flatulence. On the opposite hand, these same compounds may have defensive effects.

Dillis*et al*., (2008). stated that a major function of phenolic compounds is their antioxidant activity, it has been proposed to play a key act in countering the method of ageing and the development of assorted degenerative diseases. Several important classes of phenolic compounds, including tannins, isoflavones, and lignans, are proved to be present in pulses.

Additionally, to their antioxidant properties, isoflavones and lignans make use of a weak oestrogenic activity, which can be implicated in various mechanisms. Phenols may also be accountable for reduced mineral especially Iron bioavailability. (Dillis*et al.*,2008).

The concentration of isoflavones and lignans in pulses is mostly low, while that of tannins is considerably higher. Tannin losses because of common cooking of pulses appear to be within the order of 40-50%Pulses have small quantities of phytosterols, and therefore the most typical phytosterols such as β-sitosterol, campesterol, and stigmasterol (Singh *et al.*,2017).

Total phytosterol content present within the legumes ranged from 134 mg/100g in kidney bean and 242 mg/100g in pea. Total β-sitosterol content ranged from 160 mg/100g in chickpea to 85 mg/100g in butter bean. High levels of campesterol present in chickpea and pea 21.4 and 25.0 mg/100g.Kidney Bean contains 127 mg phytosterol per 100g chickpea has a lower concentration of Phytosterols 35 mg/ 100g (Singh *et al.*,2017).

According to the study done by Mulero*et al.,* (2020) the phytochemical composition of selected pulses including common beans, fava beans, lentils,

chickpeas, peas, and lupins has been evaluated in terms of their content of antioxidant compounds.

The content of hydrosoluble antioxidants such as organic acids, phenolic compounds, liposoluble antioxidants such as tocopherols, carotenoids, and other compounds which use antioxidant properties, like dietary fibre and minerals(zinc, selenium), has been considered, reporting that pulses are a noteworthy source of those compounds, which have chief health benefits, including prevention of cardiovascular diseases, anticarcinogenic or neuroprotective properties (Hertzler*et al.*,2020).

According to the study done by Ferreira (2021), pulses have drawn attention, not just for their main role as ecologically sustainable protein food sources compared to animal-based foods, even though animal foods such as meat and egg are high in protein but also for their unique nutrient-rich profile particularly, their high protein content.

Generally, pulse protein contents range between 17% and 30%. A recent report from the European Commission to the Council and therefore the European Parliament on the event of plant proteins within the international organization preconizes a change in consumer behaviour and preferences, including rebalancing plant versus animal protein in human consumption (Ferreira,2021).

The non -nutritive health-boosting mixture of Phytochemicals manifests antioxidant activity and also it protects the DNA from damage, phenolic compounds have antioxidant and other important physiological and biological properties, and galactooligosaccharides may obtain prebiotic activity. Pulse grains are related to a lower risk of various degenerative diseases (Vega,2010).

A review by Singh *et al.,* (2017) concluded that the consumption of pulses grains helps to lower serum cholesterol and increase the saturation levels of cholesterol within the bile. A dietary study reported that people who consumed pulses over seven weeks had low serum LDL cholesterol levels by partially interrupting the enterohepatic circulation of the bile acids and increasing the cholesterol saturation by increasing the hepatic secretion of cholesterol during the consumption of a diet consisting of beans, lentil, and field pea.

Various studies have reported the efficacy of plant sterols and stanols in the reduction of blood cholesterol levels, and plant sterols are increasingly incorporated into foods for this purpose (Dillis*et al.*,2008).

According to the study done by Dillis*et al., (2008)* Phytic acid may be a phosphorated carbohydrate that is important for regulating several functions of human cells. Many research has focused on its anti-cancer properties and it's been hypothesized that phytic acid is also responsible for the anticarcinogenic effects of dietary fibre.

Phytic acid functions as an effective antioxidant by creating complexes with Iron, thus preventing group generation (Fenton reaction) and lipid peroxidation. Phytic acid also has possible anti-cancer action. Apart from that Iron, phytic acid also binds to Zinc and Calcium, which decreases the bioavailability of those minerals and also in this study stated that Common cooking practices decrease the phytic acid in pulses, but don't eliminate the phytic acid content of pulses (Dillis*et al.*,2008).

The nutritional benefits of pulses are well recognized by governments and health organizations worldwide and are recommended as a part of healthy eating. Pulses contain good amounts of insoluble fibre which has been helping to boost colon health. In addition, various phytonutrients including antioxidants, which are present in pulses have anti-cancer properties (Curran, 2012).

Some studies conducted on the effect of pulses on appetite and satiety, study shows that the intake of pulses reduced hunger and increased satiety. On the other hand, it also has a beneficial effect on weight loss while intentional energy restriction. (Blazos*et al.*, 2016).

Pulse proteins are utilized in gluten-free products, including muffins and edible biodegradable films. However historically the general health benefits of pulses are related to these macronutrients, yet nowadays there are sufficient pieces of evidence that suggest some non-nutritional compounds present within them also play a big role in the maintenance of human health (Singh *et al.,* 2017).

Dietary intake of flavonols functions like anti-oxidant, pro-oxidant, anti-estrogenic to interdict breast carcinogenesis. Phytosterols are plant sterols having a

structure kind of like cholesterol. These compounds are substantially studied as functional food ingredients and are well known for their wide range of health benefits like lowering blood cholesterol levels and decreasing the intestinal absorption of dietary and endogenous cholesterol. Phytosterols aren't synthesized in our body and are taken from the diet by intestinal absorption (Singh *et al.,* 2017).

High protein Content and micronutrients content makes legumes an important food source. Legumes are providing protein with essential amino acids, complex carbohydrates, and fibre. Legumes also provide CHO, B Vitamins, iron, copper, magnesium, manganese, zinc, and phosphorous (Toklu*et al.*,2021).

Many legume species are unusually rich in secondary metabolites, some of which are beneficial to human health while without required processing through heating or leaching many will be detrimental to the health of the buyer. Soybean is one every of the foremost popular and also one in every of the more-healthy species (Maphosa *et al.*,2017).

Maphosa *et al.,* (2017) reported that the existence of genistein and other isoflavones makes it famous as an anti-cancer nutraceutical. Isoflavones and other phytoestrogens, occurring mainly in legumes, maybe an element promoting longevity.

Toklu*et al.,* (2021) stated that legumes also contain Glycosides, Tannins, Saponins, alkaloids, and some other bioactive compounds increasing the benefits of legumes consumption. There is the strongest link between eating legumes and reduced risk of colorectal cancer and eating soy foods reduces the level of LDL cholesterol (Blazos*et al.*, 2016).

Legumes are generally low in fat, are realistically free from saturated fat, since they are plant foods, and are cholesterol-free similarly (Polak,2015). Legumes even have a low GI, overall ranging between 10 and 40 (Blazos*et al.,* 2016).

Grain legumes are a component of balanced diets along with cereals. Normally the seeds from those two plant families give together the best source of essential amino acids and will have given an evolutionary benefit. A feasible diet for

vegetarians might not be possible without protein-rich legumes. Consumed alone, legumes will be a mixed favour due to their deficiency of a few essential amino acids (Embersdobler*et al*., 2017).

Lambein*et al.,* (2009) stated that the deficiency of a few essential amino acids is balanced in an exceedingly varied diet containing components richer in tryptophan and therefore the sulfur organic compound methionine and cysteine.

Moreover to their nutritional superiority, legumes have also been attributed economical, cultural, physiological, and medicinal part due to their advantageous bioactive compounds. Almost all of the bioactive compounds in legumes possess antioxidant properties, which play a task within the prevention of several cancers, cardiovascular diseases, osteoporosis, and other diseases (Maphosa *et al.*,2017).

Due to their structure, legumes are appealing to health-conscious consumers, celiac and diabetic patients similarly to consumers concerned with weight management (Rizkalla*et al.*, 2002). The incorporation of legumes in diets, specifically in developing countries, could play a serious role in eliminating protein-energy malnutrition peculiarly in developing Afro-Asian countries(Blazos*et al.*, 2016).

Legumes might be a base for the event of the many functional foods to market human health. (Maphosa *et. al*,2017). Legumes are an integral part of the many healthy eating patterns, including the Mediterranean sort of eating, the DASH (Dietary Approaches to Stop Hypertension) eating plan, DASH diet is a good and healthy way for peoples who wants to lose weight. Vegetarian and vegan diets, and lower GI diets (Polak,2015).

Legumes have low GI content and it is important for long-term health benefits (Toklu*et al.*,2021) Low GI diets and the phytochemicals present in legumes are going to be beneficial to decrease the cholesterol level, lose weight, reduce the danger of cancer and heart diseases. (Maphopsa*et al.*,2017).

Together with being a highly nutritious food, proofs reveal that legumes can play a crucial function within the prevention and management of a variety of health conditions (Polak,2015).

In many developing or under developing countries due to the high cost of animal proteins, they meet their required protein and bioactive for good health and nutrition from cheaper legumes sources (Toklu*et al*.,2021).

Black gram per 100g contains291.35 Kcal, 39.56g carbohydrate 44g, protein 21.97g, Fat 1.58g, 86.18 mg calcium. Soybean per 100g contains 381.45 kcal, 12.79gCarbohydrate 35.58g protein, 19.82g Fat, 239mg calcium. Green peas per 100g contain 81.26 kcal, 11.8gCarbohydrate, 7.25g Protein, 28.24mg Calcium. Green gram dal per 200g contains 325.76kcal, 52.59g carbohydrate, 23.88g protein, 1.35g Fat, 43.13mg Calcium. (Indian Food Composition Tables, 2017)

III. EFFECTS OF PLANT PROTEIN ON HUMAN HEALTH AND PHYSICAL FUNCTION

Consumer expectations for plant protein-based products are high and are expected to grow appreciably within the next decade. Factors contributing to the increase in acceptance of plant proteins include:

1. Potential health benefits referred to high consumption of plant-based diets
2. Consumer observe about adverse health effects of following diets high in animal protein

The advantage of plant proteins on long-term health and chronic diseases has been a trending topic in the past few years (Hertzler,2020).

Our body can naturally produce or synthesize 11 non-essential amino acids on their including alanine, arginine, asparagine, aspartic acid, cysteine, glutamic acid, glutamine, glycine, proline, tyrosine, and serine, whereas 9 essential amino acids need to come from our diets including leucine, isoleucine, histidine, lysine, methionine, threonine, phenylalanine, tryptophan and valine (Addison,2020).

Protein helps to support muscle growth and energy levels, build strength, repair tissues and muscles, and it is important for the assembly of enzymes and neurotransmitters that employment persistently to stay in digestion and metabolism working and brain functioning(Addison,2020).

The human body loses and restores approximately 2 million cells per second and If the human body doesn't get adequate protein from the diet, the body is unable to repair damaged cells or produce new ones (Addison,2020).

A.Plant Protein and Cardiovascular Disease and Metabolic Risk Factors

Dietary plant proteins have on decreasing cardio-metabolic risk factors and it also helps in the reduction of blood lipids, reduction of LDL cholesterol, non-high-density lipoprotein cholesterol, and apolipoprotein B (Polak*etal.*, 2015). Plant proteins have a good source of healthy plant sterols which may help to enhance heart health, prevent heart diseases and obesity and the overall well- being of the person (Krefting,2017).

Adolescents who are obsess with higher levels of plant protein are exposed to lower body fat percentages and BMI compared with higher animal protein intake adolescents. Plant protein using as a replacement for animal protein to control obesity and for its potential positive advantage for cardio-metabolic factors (Hertzler,2020).

Dillis*et al*., (2009) conducted a study with 9 healthy men, who have consumed 120g of legumes each day for 7 weeks increased the cholesterol saturation of bile in the gallbladder, biliary cholesterol secretion, and output of the faecal acidic sterol. Regular consumption of pulses (46 to 150g each day) results in decreased total cholesterol level, Low-Density Lipoprotein (LDL), and triglycerides while there is no change in High-Density lipoprotein (HDL).

B. Metabolism Booster

A review by Nikki Adisson (2020) concluded that the mix of fibre and protein means it takes the human body a long time to digest vegan whole foods. The more the body works on metabolizing the plant protein, the higher the body becomes at burning extra fat. Plant protein has the potential advantages on metabolic syndrome

C. Plant Protein and Diabetes

Replacement of 5% of energy intake from vegetable protein for animal protein was related to a 23% decreased risk of type 2 diabetes, improvements in HbA1c, fasting glucose, short-term glucose control, and fasting insulin levels in people with diabetes. Plant sources of protein have the advantage of being low fat in many cases (Blazos*et al.*, 2016).

Additionally, they provide fibre and lots of beneficial phytonutrients, all of which are lacking in animal foods. plant protein conferred a major 21% decrease in all-cause mortality risk (Macken and Sapana 2017).

According to the study done Brown (2017), people with type 2 diabetes replacing the animal sources with legumes 3days a week results in improved cholesterol levels and blood glucose levels.

Brown (2017) conducted another 6-week study with diabetes people who have consumed high plant protein sources diet with high animal protein sources. There is no difference in their blood glucose, blood pressure, and cholesterol level.

D. Plant Protein and Cancer

The benefits of increasing plant protein intake instead of animal protein are in cancer risk reduction. Plant lectins are a group of proteins and glycoproteins along with potent biological activity, they are presented in foods like corn,wheat, tomato, groundnut, kidney bean, green pea, soybean, potato, and rice(Madigan and Karhu, 2018).

Dietary intake by humans is important. Many lectins are found to have anti-cancer properties. They’re used as therapeutic agents, preferentially binding to neoplastic cell membranes or their receptors, causing cytotoxicity, apoptosis, and tumour growth inhibition (Mejia *et al.*,2005).

Certainly, the danger of developing cancer is impacted by multiple factors, like genetic predisposition, environment, and dietary and other lifestyle habits. The plant-based protein helps to prevent breast, prostate, colorectal and gastrointestinal cancers (Madigan and karhu, 2018).

High meat intake was related to a high risk of colorectal cancer among some gene carriers compared with those having the identical genetic polymorphism who consumed diets with lower meat intake. Therefore, exchanging plant protein for animal protein within the diet could also be a method to lower the danger of colorectal cancer in individuals with certain gene variants (Hertzler,2020).

E. Plant Protein and CKD

Joshi (2019) concluded that eating essentially plant-based diets are observed to consume approximately 1.0 g/kg/day of protein, or more. CKD patients are seen to consume 0.7-0.9 g/kg/day of mostly plant-based protein with no negative effects.

In addition, those exchanging animal-based proteins for plant-based proteins have shown reductions in the severity of hypertension, hyperphosphatemia, and acidosis. Plant-based proteins, when consumed during a varied diet, aren't only nutritionally adequate but have pleiotropic effects which can favour their use in chronic kidney disease (CKD) patients (Joshi,2019).

F. Antinutrients

At low levels, phytates, lectins, phenolic compounds, enzyme inhibitors, and saponins may help to cut back blood sugar and/or plasma cholesterol and triglycerides Saponins may help liver function and reduce platelet agglutination and a few saponins, still as phytates, protease inhibitors, lignans, and phytoestrogens, may reduce cancer risk (Hertzler,2020).

Hertzler (2020), reported that in addition, tannins may have antimicrobial effects. As such, a number of the health benefits of plant-based diets could also be attributed to the presence of low levels of those "antinutrients".

G. Improved Digestion

Legumes have a good source of healthy fibre that naturally enhances digestion and absorption, improves motility, and decreases symptoms of gas and bloating (Addison,2020).

H. Protection against Weight Gain

High protein diets may additionally facilitate the control of body weight. Brown (2017) conducted an observational study with 120,000 people above the age of 20 years, it proved that people who are eating more nuts and legumes have lost their weight and also in this study he stated that consuming one serving of legumes each day can increase the satiety and should result in good weight management and weight loss.

The Study reported that adults who have consumed legumes frequently have normal BMI levels, 23% reduced the risk of high waist circumference and 22% reduced the chance of obesity (Blazos*et al.*, 2016).

I. Restrict added Hormones and Antibiotics

Most animal-based sources of protein have added hormones and antibiotics while plant-based sources of protein are packed with antioxidants, phytochemicals, vitamins, and minerals which are needed for optimal health. (Addison,2020)

J. Complete Proteins

Many people assume that animal protein sources are the sole complete proteins; this can simply not be true. Soy, tempeh, and peas are complete sources of protein. There also are many ways to mix vegan foods in a meal(Addison,2020).

IV. EXISTING PROTEIN POWDERS

A. The Appeal of Pea Protein

Over the last few decades, there has been increased importance in varying protein options. From protein bars/powders to additives in vegan or vegetarian foods, people are specializing in the facility of protein in their daily diet. Whey and soy proteins are the quality supplemental sources a few times, but other plant proteins have seen a rise in popularity. (Krefting,2017)

These same plant proteins may be beneficial to other populations, such as the elderly, in terms of maintaining muscle mass and slowing the aging- related process of Sarcopenia. Pea and other plant proteins have not yet been studied in older adults with sarcopenia, despite their apparent usefulness in athletes. Pea protein contains far

more leucine than is advised, suggesting that it could be useful in preventing skeletal muscle loss. (Salles *et al*., 2021)

Plant-based diets are shown to cut back the chance of obesity, high BP, and diabetes; numerous consumers have turned to those vegetarian proteins to supply identical outcomes. Unlike many other protein powders, pea protein isn't derived from 1 of the 8 most typical allergenic foods including milk, eggs, peanuts, tree nuts, soy, fish, shellfish, and wheat, allowing another choice forthose following restricted diets. (Jiao Ge *et al*., 2020)

Peas are a rich source of lysine, the precursor to carnitine which helps to convert fatty acids into energy. Lysine might also help maintain a healthy system. Peas are also a good source of purines, which can cause gout flare-ups in patients. Pea protein powders may also produce much gastrointestinal upset or distress. Pea protein has started to show up in other nonvegetarian foods as well, acting as an emulsifier or adding protein. (Krefting,2017)

B.Vegalite Protein Powder-A Great-Tasting Blend of Rice and Pea Proteins for Vegetarians, Vegans, or Those Intolerant to Dairy Products

Pea proteins is a relatively new form of plant protein that has found its way into the global food market as a useful component. The four principal types of pea protein are globulin, albumin, prolamin and glutelin, with globulin and albumin serving as major protein in pea seeds. Pea protein is well balanced with a high quantity of lysine. (Lu *et al*., 2019).

Additionally, they contain high-quality starch and fibres. The foremost promising substitute for soy protein products is pea protein isolates. As within the case of soy protein isolates, techno-functional properties such as solubility, emulsifying, foaming, and gelling properties of pea isolates are well recorded. Pea seeds contain about22-23% proteins. The bulk of pea proteins is globulins and albumins that represent about 80% of the total protein content of the seed. Albumins produce 18-25% and globulins 55-65% of total proteins. (Shuklal,2017).

C. Formation of Vegan, Lactose-free Protein Powder Enriched with Vitamin D & study its Sensory Properties

Malnutrition and deficiencies of nutrients within the common public are incredibly much prevalent in India. One such needed nutrient is protein. 2 in 3 people or 73% population in India are hypoproteinemic, so protein should be added to their daily diet. In children who are suffering from prolonged protein deficiencies, diseases like Kwashiorkor and Marasmus can develop. (Garg and Dalal,2020)

The most ingredients used were Soybean (Glycine max), Amaranth (Amaranthus) seeds, Peas (Pisum sativum), Lentil dal (Lens culinaris), Agathi (Sesbania grandiflora) leaves, Groundnut (Arachis hypogaea), and Oyster Mushrooms (PleurotusOstreatus). (Garg and Dalal,2020)

The method used for the preparation of the protein powder was blanching, Parching, roasting, drying, dehydrating, grinding, and homogenization. Daily consumption of plant-based diets reduces the prevalence of the development of metabolite c syndrome. Organoleptic properties were observed using the triangle test, 9-point hedonic test, and ranking test. While nutritional evaluation was finished energy, protein, carbohydrate, fibre, fat, ash, and vitamin D content. It can help against Protein Energy Malnutrition (PEM) and relieve the consequences of nutritional deficiencies (Garg and Dalal,2020)

III. METHODOLOGY

The methodology of the study titled "DEVELOPMENT OF VEGAN PROTEIN POWDER AND ITS QUALITY ANALYSIS" is discussed in the following phases

PHASE I

A. Development of vegan protein powder using pulses and legumes as the base and determination of its nutritive value
B. Isolation of protein from selected pulses and legumes and its shelf life and nutrient analysis

PHASE II

A. Formulation of recipes using the developed vegan protein powder
B. Sensory evaluation of the developed recipes

PHASE III

A. Development of e-questionnaire and assessment of knowledge of women on vegan protein powder
B. Development of education module and Creation of awareness on developed vegan protein powder among selected women
C. Analysis and Interpretation of data

PHASE I

A. Development of Vegan Protein Powder using pulses and legumes as the base and determination of its nutritive value calculation

Legumes and pulses are part of our daily food staple. They are inexpensive as well as rich in protein, other nutrients and phytochemicals which help in the maintenance of health. Pulses and legumes contain bioactive chemicals that have a vital role in physiological and metabolic processes.

Various pulses and legumes were selected based on their nutritive and therapeutic value. The ingredients were processed and developed into vegan protein powder.

The study was approved by the Institutional Human Ethical Committee Approval Number:IHEC/FSMD-21-22/XMT-19)(Annexure I).

The below list of ingredients is known to be a good source of protein content. Hence, they were selected for the formulation of the vegan protein powder.

1. Green gram (*Vigna radiata*): It increases the protein content without increasing fat content. It further helps to build the growth of beneficial microbiota in the gut (Sudhakaran and Bukkan, 2021).
2. Green peas (*Pisum sativum*): Contains lysine which helps in augmenting the proper immune system (Krefting,2017).
3. Black gram dal (*Vigna mungo*): Helps to strengthen the muscle fiber and aids in the control of hormonal imbalance(Rettu, and Kaur, 2021).
4. Soya bean (*Glycine Max*): It is a good substitute for meat due to its high nutritional value (Friedman and Brandon,2001).

Peas*(Pisum sativum)*

Green Gram*(Vagina radiata)*

Black Gram Dal*(Vigna mung)*

Soyabean*(Glycine max)*

Plate I

SELECTION OF INGREDIENTS FOR DEVELOPMENT OF VEGAN PROTEIN POWDER

The selected ingredients as mentioned above were made to undergo a process that contained washing, drying, dry roasting, pulverizing, sieving, direct mixing, and packaging towards the development of vegan protein powder.The developed protein powder was conceived and formulated in such a way that consumption of 30g of the same would provide 1/3 of the RDA (20 g) of protein Another attempt was made to isolate the protein from the developed powder to make available the same protein content with lower consumption of pulses and legumes.

The detailed steps towards the development of the vegan protein powder are as follows:

100g each of green gram, peas, black gram dal, and soyabean were washed and sun-dried. The dried ingredients were ensured to be crisp with a strong and hard outer layer. The dried Pulses were then dry roasted for about 5 - 10 minutes and were allowed to cool to room temperature.

Once they reach room temperature, they were pulverized to obtain a fine powder. This powder was further sieved with a fine-mesh sieve to remove any larger chunks. The remaining larger granules were further ground for a few more minutes and sieved once again to obtain uniform vegan protein powder. The vegan protein powder was stored in a clean container.

Peas*(Pisum sativum)*

Green Gram*(Vagina radiata)*

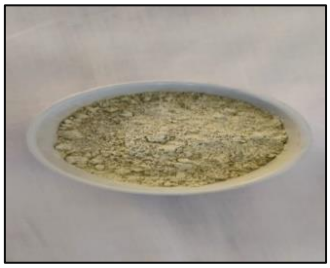
Black Gram Dal*(Vigna mung)*

Soyabean*(Glycine max)*

Plate II

ROASTED PULSES AND LEGUMES

Peas *(Pisum sativum)*



Green Gram *(Vagina radiata)*

Black Gram Dal *(Vigna mung)*

Soyabean *(Glycine max)*

PLATE III

POWDERED PULSES AND LEGUMES

1. **Composition preparation of developed vegan protein powder and its nutritive value calculation**

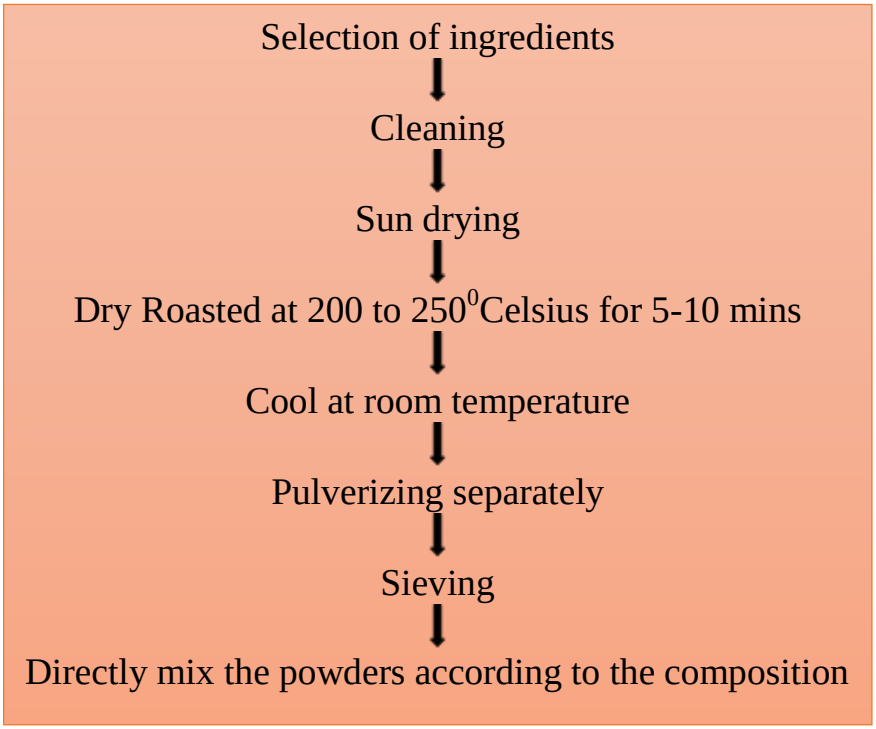


FIGURE I

DEVELOPMENT OF VEGAN PROTEIN POWDER

TABLE I

COMPOSITION OF DEVELOPED VEGAN PROTEIN POWDER

Pulses and Legumes	Composition 1(C1)	Composition 2(C2)	Composition 3(C3)
Green Gram	30g	25g	30g
Peas	30g	30g	25g
Black Gram Dal	20g	20g	15g
Soybean	20g	25g	30g

Three different compositions were prepared with the variation of the green gram, peas, Soybean and Black Gram Dal. The sample was named C1, C2 and C3. The composition of Green Gram was 30g, 25g and 30g in samples C1, C2 and C3 respectively. The composition of Peas was 30g, 25g and 25g in samples C1, C2 and C3 respectively. The composition of Black Gram Dal was 20g, 20g and 15g in samples C1, C2 and C3 respectively. The composition of Soybean was 20g, 25g and 30g in samples C1, C2 and C3 respectively. All the 3 compositions of developed powder were evaluated for sensory attributes using a five-point hedonic scale by four members. The nutritive value of the selected ingredients for the development of vegan protein powder was calculated by using the Indian Food Composition Tables.

B. Isolation of protein from selected pulses and legumes and its shelf life and nutrient analysis

Protein isolation is a procedure of separating protein from the selected protein sources (Green Gram, Green peas, Urad dal, Soyabean). The protein isolation was done in the laboratory.

100 mg of protein was added to 2 ml of extraction buffer comprising (100 mM dibasic potassium phosphate (pH 7.6), 8 mM urea, 1% Triton X-100, 20% glycerol, and 0.5 M NaCl). This solution was shaken for 10-15 minutes at room temperature before centrifuging at 6500g for 30 minutes at 40 degrees Celsius. The supernatant was removed, and an equal volume of 10% TCA containing 2% Beta Mercaptoethanol was added and stored overnight at -200°C for precipitation. The mixture was centrifuged at 5000g for 30 minutes at 40 degrees Celsius the next day.

The precipitate was washed three times in ice-cold acetone after the supernatant was discarded (Jebitta, 2021).

100 mg of protein treated with 2ml of extraction buffer (100mM dibasic potassium phosphate (pH 7.6),8M urea, 1% triton X-100,20% glycerol, 0.5 M Nacl).

↓

Solution placed in a shaker at room temperature for 10 -15 mins

↓

Centrifuged at 6500g for 30 minutes at 4^0celsius

↓

Supernatant was separated

↓

Added equal volume of 10% TCA containing 2% Beta Mercaptoethanol

↓

Stored overnight for precipitation at -200^0Celsius.

↓

The mixture was centrifuged at 5000g for 30 minutes at 4^0Celsius.

↓

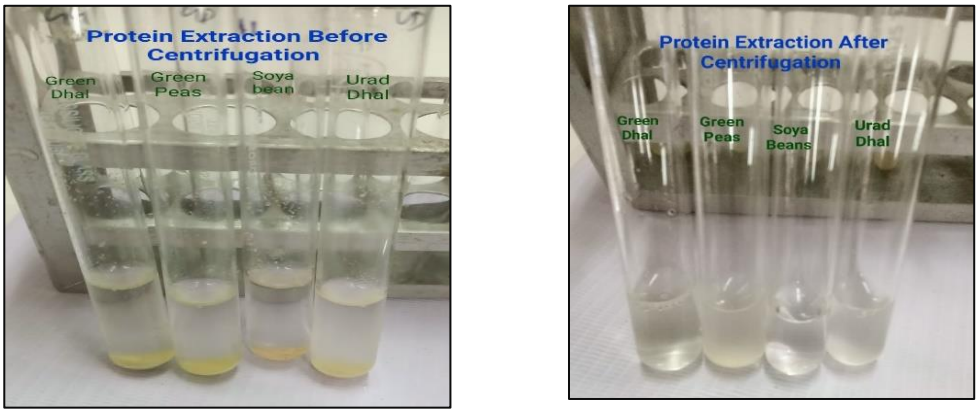
The supernatant was discarded and the precipitate was washed three times in ice-cold acetone.

Source: (Jebitta*et al*.,2021)

FIGURE II

ISOLATION OF VEGAN PROTEIN POWDER

Protein Extraction



Before Centrifugation ***After Centrifugation***

PLATE IV

CENTRIFUGATION OF PROTEIN EXTRACTION

Peas *(Pisum sativum)*

Green Gram *(Vagina radiata)*

Black Gram Dal *(Vigna mung)*

Soyabean *(Glycine max)*

PLATE V

ISOLATED VEGAN PROTEIN POWDER

3. Nutritive analysis, and shelf life of the isolated vegan protein powder

The fresh sample of the isolated vegan protein powder was used for nutritive analysis and the determination of shelf life. The nutritive analysis is the process of evaluating the nutrient content of the developed food products or food.

a. Estimation of protein in isolated protein powder

Lowry's technique was used to calculate the amount of isolated protein powder. In five test tubes, 0.2 ml of BSA. A was used as a working standard, and distilled water was used to make up to 1 ml. The blank was a test tube filled with 1 mL of distilled water. Incubate for 10 minutes with 4.5 ml of Reagent 1 (48 ml of 2 percent Na2Co3 in 0.1 N NaOH, 1 ml of 1 percent NaK Tartrate in H2O, 1 ml of 0.5 percent CuSO4.5 H2O in H2O). After 30 minutes of incubation, add 0.5ml of Reagent II (1 part 2N Folin-Phenol: 1 part water) and incubate for another 30 minutes. At 660 nm, the color generated was calorimetrically measured. The amount of protein present in the given sample was determined using a standard graph (Lowry *et al*., 1951).

0.2 ml of BSA was taken as working standard in 5 test tubes

⬇

Made up to 1ml using distilled water.

⬇

A test tube filled with 1 ml distilled water as blank

⬇

Add 4.5 ml of Reagent 1 (48ml of 2%Na2Co3 in 0.1 N NaOH, 1ml of 1% NaK Tartrate in H2O, 1 ml of 0.5% CuSO4.5 H2O in H2O)

⬇

Incubated for 10 Minutes

⬇

Added 0.5ml of Reagent II (1part 2N Folin-Phenol: 1 Part water)

⬇

Incubate for another 30 minutes

⬇

The color developed was measured calorimetrically at 660 nm

⬇

The amount of protein present in the given sample was determined using a standard graph

Source: (Lowry *et al*., 1951)

FIGURE III

ESTIMATION OF PROTEIN IN ISOLATED PROTEIN POWDER

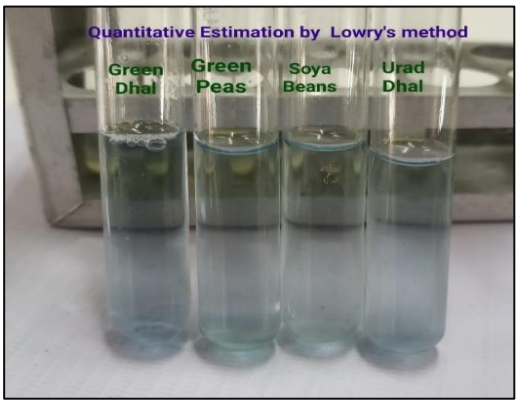


FIGURE IV

QUANTITATIVE ESTIMATION OF ISOLATED PROTEIN POWDER BY LOWRY'S METHOD

b. Carbohydrate

Reagents

- 2.5N HCl
- Anthrone reagent: Dissolve 200 mg anthrone in 100 mL ice-cold 95 percent sulfuric acid.
- Standard Glucose (stock): Dissolve 100 mg in 100 mL purified water before using.
- Working standard: 10 mL stock diluted in distilled water to 100 ml. After adding a few drops of Toluene, keep it refrigerated**.**

Procedure

In a boiling tube, weigh 100 milligrams of the sample. Cool to room temperature after 3 hours of hydrolysis in a boiling water bath with 5 ccs of 2.5 N HCl. Remove the effervescence by neutralizing it with solid sodium carbonate. Fill to 100 mL with water and centrifuge. Take 0.5 and 1ml aliquots of the supernatant for analysis. Make the standards by combining 0, 0.2, and 0.4, 0.6, 0.8, and 1 ml, with '0' serving as a blank. By adding distilled water to all of the tubes, including the sample tubes, increase the volume to 1 ml. Add 4 mL of Anthrone reagent after that. In a boiling water bath, heat for 8 minutes. At 630 nm, check for a green to dark green color change. Make a standard graph by graphing the standard concentration on the X-axis against the absorbance on the Y-axis. Calculate the amount of carbohydrate in the sample tube using the graph. (Source: FSSAI Manual)

c. Fat

Reagent

- Petroleum Ether (40°C to 60°C boiling point)

Procedure

Weigh 2.5 grams of dry material into a thimble and extract with petroleum ether in a Soxhlet or other suitable extractor. The extraction time can range from 4 hours with a condensation rate of 5 to 6 droplets per second to 16 hours with a condensation rate of 2 to 3 drops per second. Dry the extract for 30 minutes in a steam bath, then chill in a desiccator before weighing. Alternate drying and weighing at 30-

minute intervals until the difference between two successive weighings is less than one milligram. Take notice of the lowest mass. (18th Edition AOAC)

d. Fiber

Procedure

To remove fat, extract 1-2g of powdered material with ether or petroleum ether (boiling temperature 35-38°C, final temperature 52°C). If the fat content is less than 1%, extraction may be skipped. Boil 2g of dry material in 200mL sulphuric acid for 30 minutes with bumping chips after extraction with ether. Filter through muslin and rinse in boiling water until the water is no longer acidic. Boil for 30 minutes with 200mL sodium hydroxide solution. Wash with 25mL boiling 1.25 percent H2SO4, three 50mL pieces of water, and 25mL alcohol after filtering through muslin cloth again. Remove the residue and transfer it to the ashing dish (pre-weighed dish W1). Dry the residue at 130°C for 2 hours. Cool the dish in a desiccator and weigh (W2). Ignite for 30 minutes at 600°F/15°C 9. Reweigh after cooling in a desiccator (W3). (BIS,)

The shelf-life of the product was assessed to determine the most accurate best-by date for the developed product.

e. Total plate count

The total plate count or standard plate count is used to determining the extent of microbial invasion. It is used to estimate the number of microorganisms such as yeast, mold and bacteria, present in the isolated vegan protein powder. (Upadhyay *et al*.,2017)

f. E. coli

SCOPE

This standard (Part I) prescribes methods for and enumeration of *Escherichia coli* in foods.

PRINCIPLE

Spread plates are made using a specific selective medium and a specific amount of decimal dilution of the test sample, then incubated for 24 hours at 370 degrees Celsius.

PROCEDURE

Dilution:

0.1% peptone salt solution - Himedia M1748 sterilized by autoclaving at 1210 C/15 lbs pressure.

Inoculation:

Pour about 15 ml of the Tergitol - 7 Agar into a sterile petri dish, Leave the Petri dishes on a cool horizontal surface to harden the mixture.

Spread 0.1 ml of the each ($10^{-2,}10^{-3}$, 10^{-4}) dilution evenly on Tergital 7 Agar,

Incubation:

Incubate the prepared dishes at 37 °C $\pm$1 °C for 24 hrs

Do not stack the dishes more than six high.

Stacks of dishes should be separated from one another and the walls and top of the incubator.

Interpretation & Counting of the colonies:

Count the colonies using the colony counteron each plate after 24hrs of incubation.

Colony identification: yellow surrounded by a yellow zone. (BIS 5887 :Part 1,1976)

g. Salmonella

SCOPE

This Method Gives general guidelines for the Detection of*Salmonella* spp. organism presentin the food sample.

PROCEDURE

Take a loop full of saline in a clean glass slide mix with a inoculate growthfrom each NA slant and mix with a drop of salmonella polyvalent serum (H). Stir the mixture for 1 minute and observe against a dark backdrop in good lighting; a control with 0.85 percent saline and salmonella polyvalent serum is also retained. (H).

Take a loop full of saline in a clean glass slide mix with a inoculate growthfrom each NA slant and mix with a drop of salmonella polyvalent serum (H). Stir the mixture for 1 minute and observe against a dark backdrop in good lighting; a control with 0.85 percent saline and salmonella polyvalent serum is also retained. (O).

Positive - White precipitated indicates a positive reaction

Negative - No agglutination in test serum. No agglutination in control. (BIS 5887:Part 3,1999)

PHASE II

A. Formulation of recipes using the developed vegan protein powder

A variety of recipes were formulated with the developed vegan protein powder. The recipes were formulated in such a manner that they could be consumed for breakfast, lunch, dinner, snacks, etc. Some of the developed recipes include puttu for breakfast, chapati for lunch, dosa for dinner, Bengal gram balls and coconut milk milkshake for snacks.

1.Puttu

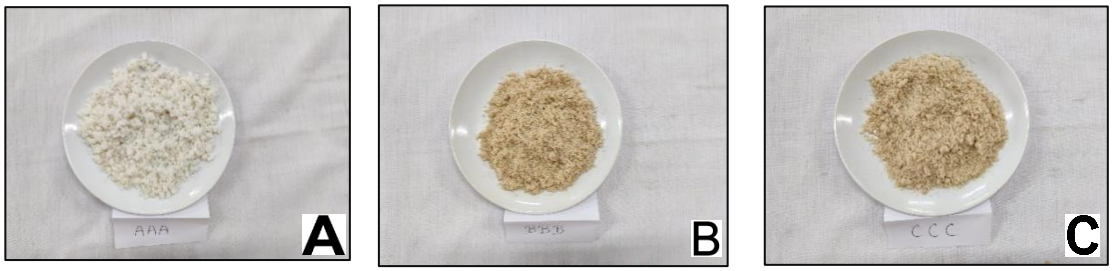
TABLE II

COMPOSITION OF VEGAN PROTEIN POWDER INCORPORATED PUTTU

Ingredients	Standard	Variation I	Variation II
Rice flour(g)	60g	60g	60g
Vegan protein powder(g)	-	20g	40g

Variation I - 20g Vegan protein powder incorporated Puttu
Variation II - 40g vegan protein powder incorporated Puttu

Recipes were prepared using vegan protein powder in the above incorporation level.



Standard | **Variation I** *(20g vegan protein powder incorporated recipe)* | **Variation II** *(40g vegan protein powder incorporated recipe)*

PLATE VI

VEGAN PROTEIN POWDER INCORPORATED PUTTU

2. Chapati

TABLE III

COMPOSITION OF VEGAN PROTEIN POWDER INCORPORATED CHAPATI

Ingredients	Standard	Variation I	Variation II
Wheat flour(g)	50g	50g	50g
Vegan protein powder(g)	-	20g	40g

Variation I - 20g Vegan protein powder incorporated chapati

Variation II - 40g vegan protein powder incorporated chapati

Recipes were prepared using vegan protein powder in the above incorporation level.

Standard | **Variation I** *(20g vegan protein powder incorporated recipe)* | **Variation II** *(40g vegan protein powder incorporated recipe)*

PLATE VII

VEGAN PROTEIN POWDER INCORPORATED CHAPATI

3. Dosa

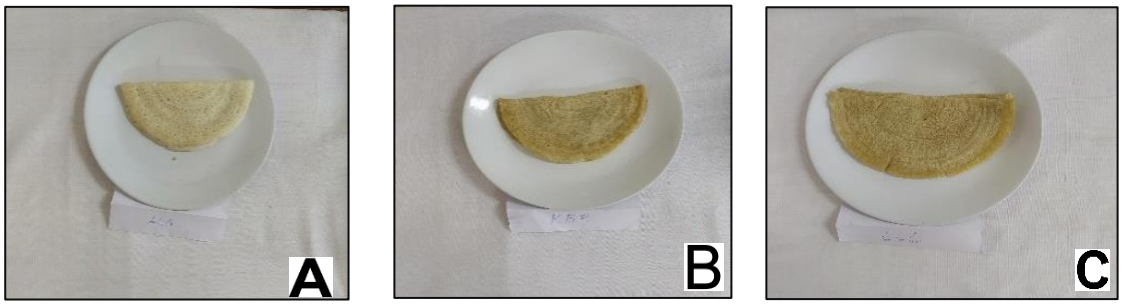
TABLE IV

COMPOSITION OF VEGAN PROTEIN POWDER INCORPORATED DOSA

Ingredients	Standard	Variation I	Variation II
Dosa batter (g)	30g	30g	30g
Vegan protein powder(g)	-	20g	40g

Variation I - 20g Vegan protein powder incorporated Dosa
Variation II - 40g vegan protein powder incorporated Dosa

Recipes were prepared using vegan protein powder in the above incorporation level.



Standard

Variation I
(20g vegan protein powder incorporated recipe)

Variation II
(40g vegan protein powder incorporated recipe)

PLATE VIII

VEGAN PROTEIN POWDER INCORPORATED DOSA

4. Bengal Gram Balls

TABLE V

COMPOSITION OF VEGAN PROTEIN POWDER INCORPORATED BENGAL GRAM BALLS

Ingredients	Standard	Variation I	Variation II
Roasted Bengal gram powder	50g	50g	50g
Jaggery	30g	30g	30g
Vegan Protein powder	-	20g	40g

Variation I - 20g Vegan protein powder incorporated Bengal gram balls
Variation II - 40g Vegan protein powder incorporated Bengal gram balls

Recipes were prepared using vegan protein powder in the above incorporation level.

Standard | **Variation I** *(20g vegan protein powder incorporated recipe)* | **Variation II** *(40g vegan protein powder incorporated recipe)*

PLATE IX

VEGAN PROTEIN POWDER INCORPORATED BENGAL GRAM BALLS

5. Coconut Milk Milkshake

TABLE VI

COMPOSITION OF VEGAN PROTEIN POWDER INCORPORATED COCONUT MILK MILKSHAKE

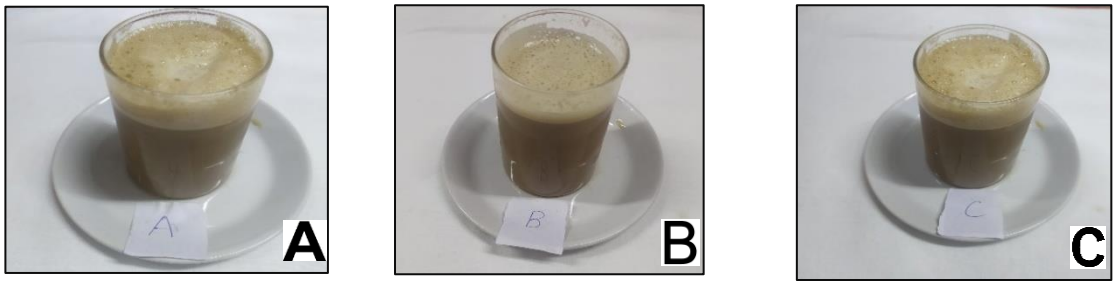
Ingredients	Variation 1	Variation II	Variation III
Coconut milk	200ml	50	50
Palm sugar	30g	30g	30g
Vegan Protein powder	10	20	30

Variation I - 10g Vegan protein powder incorporated coconut milk milkshake

Variation II - 20g Vegan protein powder incorporated coconut milk milkshake

Variation III - 30g Vegan protein powder incorporated coconut milk milkshake

Recipes were prepared using vegan protein powder in the above incorporation level.



Variation I *(10g vegan protein powder incorporated recipe)* | **Variation II** *(20g vegan protein powder incorporated recipe)* | **Variation III** *(30g vegan protein powder incorporated recipe)*

PLATE X

VEGAN PROTEIN POWDER INCORPORATED COCONUT MILK MILKSHAKE

B. Sensory evaluation of the formulated recipes

Sensory evaluation is a scientific procedure that uses human senses to evaluate food products using the principles of experimental design and statistical analysis. There are several sensory methods available to evaluate a product. In this study, a 5-point hedonic scale was used for evaluating the developed vegan protein powder recipes. These parameters that were evaluated include appearance, colour, taste, flavour, consistency, and overall acceptability of the product. (Jain and Gupta,2005)

The next step involved the selection of panelists to perform the sensory evaluation.

The selection criteria for the panelist include their willingness, capability, sensitivity, availability, and reliability. The panel should generally consist of 25 to 30 members and a minimum of 6 would be needed for a trained panel. Sensory evaluation was practiced according to the procedures given by the International Food technologist (IFT, 2017).

The developed recipes were coded and the coded samples were presented to each of the selected panelists. Each panelist tasted all the recipes and provided their scores against each of the above parameters listed.

The evaluation was done on a 5-point hedonic scale, with 1 indicating a strong dislike, 2 indicating a slight dislike, 3 indicating neither a like nor a dislike, 4 indicating a slight liking, and 5 indicating a strong liking.

Phase III

A. Assessment of knowledge of women on vegan protein powder

Adult women (n=60) in the age group 21-40 years were selected for the assessment of knowledge on vegan protein powder. A well-structured E-questionnaire was framed to collect the information.

The E-questionnaire was shared with the selected 60 adult women through a google form. E-questionnaire consisted of two sections in which the first section dealt with the demographic profile and socioeconomic status of the subjects.

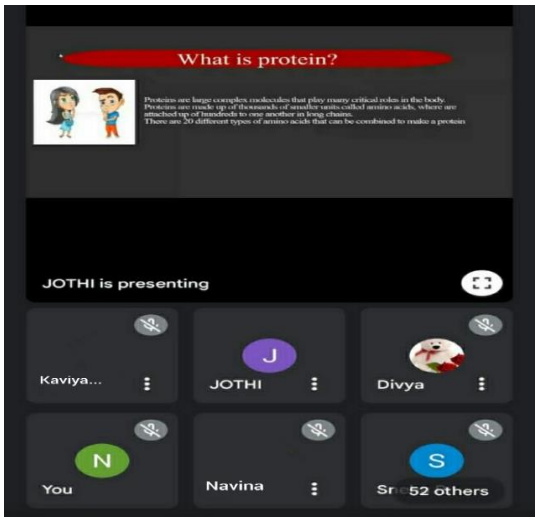
The second section contained questions related to the dietary pattern, consumption pattern of meat, plant-based foods, knowledge of benefits of vegan protein powder, protein intake, and finally, their knowledge of benefits of vegan protein powder was included. The developed E-questionnaire is enclosed as Annexure-III.

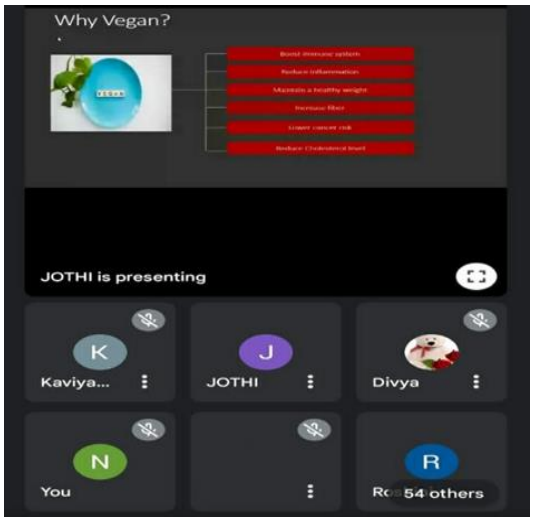
B. Development of education module and Creation of awareness on developed vegan protein powder among selected women (21-40 years)

A total of 60 adult women between the ages of 21 and 40 were chosen as participants in the study. Women's bodies change dramatically between the ages of 21 and 40, including weight gain owing to postpartum depression, PolyCystic Ovary Syndrome Pregnancy, etc. Collagen is the most generous protein in the human body, which begins to decline from the age of 30 and is more pronounced as the age increases. This results in signs of aging, loss of skin elasticity, etc.

The above was made as part of the education module. The Education module further contained data on the importance of vegan protein powder and its health benefits. It had further details regarding the requirements of macro and micronutrients, the importance of protein intake, benefits of vegan protein powder, ways to increase the consumption of protein, etc

These data were collected from well-renowned journals, articles, and books. The collected information was compiled and converted into a PowerPoint in English with a lot of pictorial illustrations to enable better understanding. The education module is enclosed as Annexure-IV.





c) Data Analysis and Interpretation

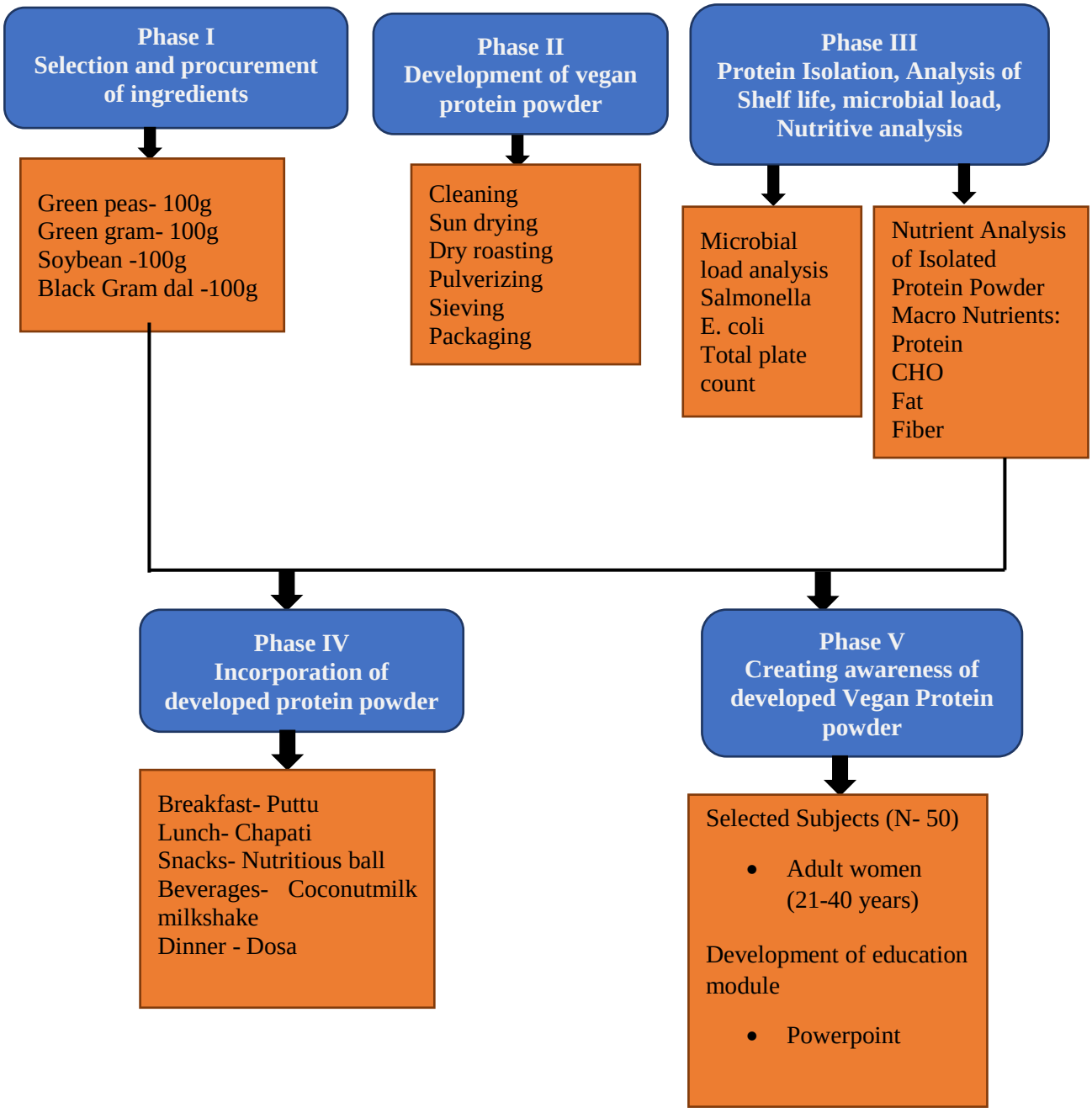
Data from all phases of the project was evaluated and interpreted. The interpretation was done by using SPSS software. The methods used to analyze the collected data like One-way ANOVA to find significance, chi-square, frequency, and correlations to find an association between the variables were used according to the nature of the data.

PLATE XI

SENSORY EVALUATION OF VEGAN PROTEIN POWDER INCORPORATED RECIPES

STUDY ON THE DEVELOPMENT OF VEGAN PROTEIN POWDER AND ITS QUALITY ANALYSIS

RESEARCH DESIGN



IV RESULT AND DISCUSSION

The findings of the study titled "**Development of Vegan Protein Powder and its Quality Analysis"** are presented under the following headings

I. Development of vegan protein powder and determination of its nutritive value
II. Protein isolation and its quality analysis
III. Sensory evaluation of developed vegan protein powder incorporated recipes
IV. Collection of Data on Demographic Profile, Assessment of the level of knowledge on vegan protein powder among selectedwomen.
V. Creation of awareness on vegan protein powder among selected subjects

Phase I: Development of vegan protein powder and nutritive value calculation

Three different compositions were prepared with the variation of the Green gram, peas, Soybean and Black Gram Dal. The sample was named C1, C2 and C3. The developed powder was evaluated for sensory attributes and its nutritive value was calculated.

TABLE VII

SENSORY EVALUATION OF COMPOSITION OF DEVELOPED VEGAN PROTEIN POWDER

	Composition 1 (C1)	**Composition 2 (C2)**	**Composition 3 (C3)**
Appearance	3.5±0.57	3.75±0.5	5±0.00
Colour	3.75±0.5	3.5±0.5	4.75±0.5
Texture	4.0±0.00	4.0±0.00	4.0±0.00
Flavour	4.0±0.00	4.0±0.81	5.0±0.00
Taste	3.75±0.5	4.0±0.00	5.0±0.00
Overall acceptability	4.0±0.00	3.75±0.5	5.0±0.00

The sample that performed the best was C3. This sample included 30g of the Green gram, 25 of peas, 15g of Black Gram dal and 30g of Soybean. Once finalized C3 is the most acceptable and liked the sample. The sample C3 was subjected to preparing various vegan protein powder incorporated products such as Puttu, Chapati, Dosa, Bengal gram balls, and coconut milk milkshake.

TABLE VIII

NUTRIENT COMPOSITION OF DEVELOPED VEGAN PROTEIN POWDER

The following table reveals the presence of the selected essential nutrients and minerals in the developed Vegan protein powder.

Nutrient	Composition 1 (C1)	Composition 2 (C2)	Composition 3 (C3)
Energy (Kcal)	331	335	336
Carbohydrate (g)	43	43	41
Protein (g)	26	27	27
Fat(g)	5	6	7
Fiber(g)	12	12	14
Calcium(mg)	111	118	128
Sodium(mg)	12.41	11.52	10.62
Potassium(mg)	1132	1153	1198

(Source: Indian Food Composition Tables,2017)

The energy content of composition 3 is higher when compared with composition 1 and 2. Composition 2 and 3 had an equal content of protein (27g) whereas the carbohydrate content was higher in composition 1 and 2 (43g) when compared with composition 3. Composition 1 had the least content of fat (5g). As the quantity of ingredients varied the nutritive value of the developed powder also varied.

Phase II: Estimation of protein in Isolated Protein powder by Lawry's method

TABLE IX

ESTIMATION OF TOTAL PROTEIN CONTENT BY GRAPHICAL METHOD

S.No.	Samples	µg/ ml
1.	GG	14
2.	GP	1.34
3.	SB	2.6
4.	UD	0.6

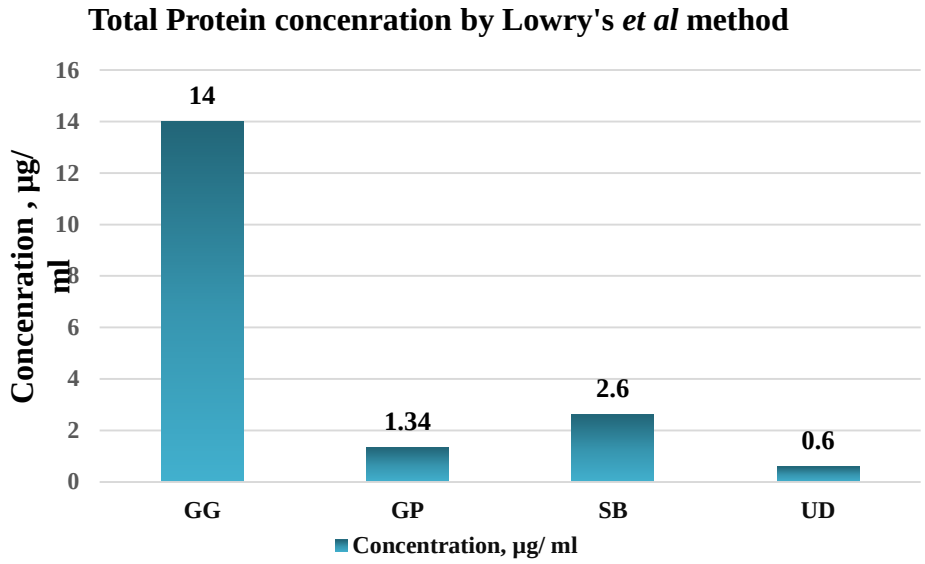


FIGURE V

TOTAL PROTEIN CONCENTRATION

The total protein concentration in the isolated vegan protein powder was calculated using a calorimetric method at 660nm and a standard graph was obtained. 0.2 ml of the green gram, Peas, Soybean and Black Gram Dal contained 14**,** 1.34, 2.6, and 0.6 µg of protein respectively.

TABLE X

Table X indicates the Nutrient analysis of the isolated vegan protein powder

Nutrients	**Result**
Carbohydrate	34.4g
Protein	58.5g
Fat	1.61g
Fiber	3.02g

It was figured out from table X, that the carbohydrate content of the isolated vegan protein powder was 34.4g. The protein content was 58.5g and 1.61g of fat was found in 100g of isolated vegan protein powder. The fiber content was found as 3.02g in the isolated protein powder.

TABLE XI

Table XI indicates the shelf-life analysis of the isolated vegan protein powder on 1st day.

Parameters	**Result**
Total Plate count	30 CFU/g
E. coli	Absent
Salmonella	Absent

From table XI, it was clear that the total plate count present in isolated vegan protein powder has 30 CFU/g, the presence of E. coli and salmonella on 1st day was absent in the isolated vegan protein powder.

TABLE XII

Table XII indicates the shelf-life analysis of the isolated vegan protein powder on the 7th day.

Parameters	**Result**
Total Plate count	180 CFU/g
E. coli	Absent
Salmonella	Absent

From table XII, it was clear that the total plate count present in isolated vegan protein powder has 180 CFU/g, the presence of E. coli and salmonella on the 7th day was absent in the isolated vegan protein powder.

Phase III: Sensory Evaluation of Developed Vegan Protein Powder Incorporated Recipes

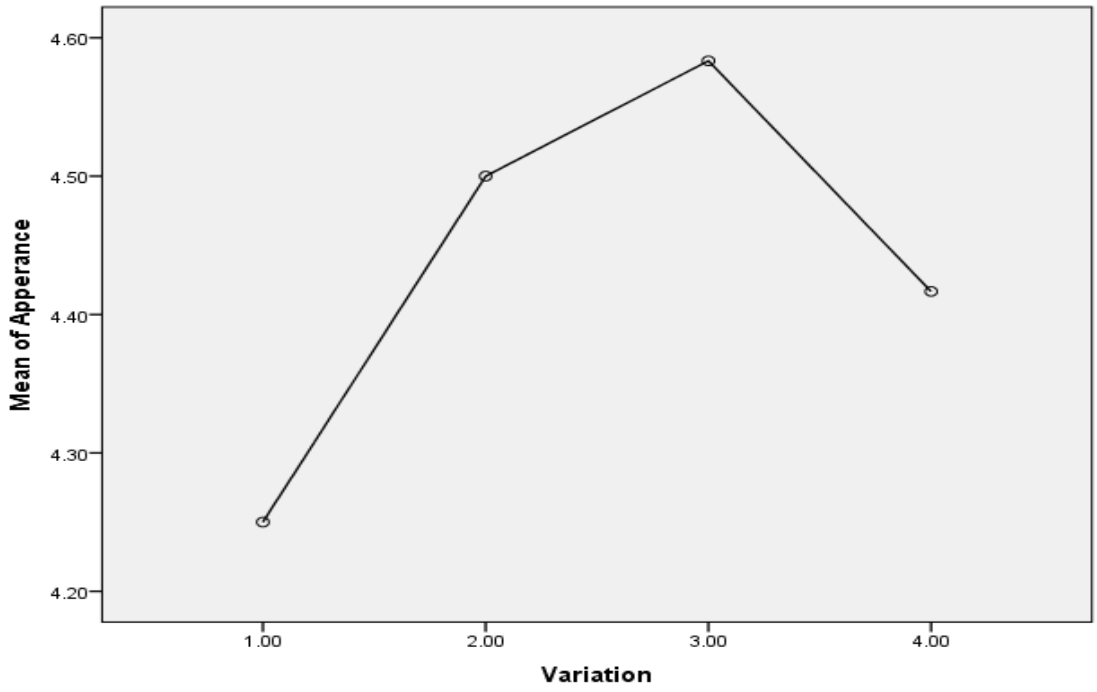
The vegan protein powder incorporated products were evaluated for their sensory characteristics and the data for the appearance of the vegan protein powder formulated recipes are presented in Table XIII.

TABLE XIII

APPEARANCE SCORE OF VEGAN PROTEIN POWDER INCORPORATED RECIPES

Table XIII indicates the scores for the appearance of all the vegan protein powder incorporated recipes in three variants.

	Puttu	**Chapati**	**Dosa**	**Bengal Gram Balls**	**Coconutmilk Milkshake**
Variation I	4.5±0.5	4.75±0.43	4.75±0.43	4.75±0.43	4.75±0.43
Variation II	4.5±0.5	4.75±0.43	4.75±0.43	4.75±0.43	4.75±0.43
Variation III	3.5±0.5	4±0.70	4.25±0.43	3.75±0.43	4.5±0.5



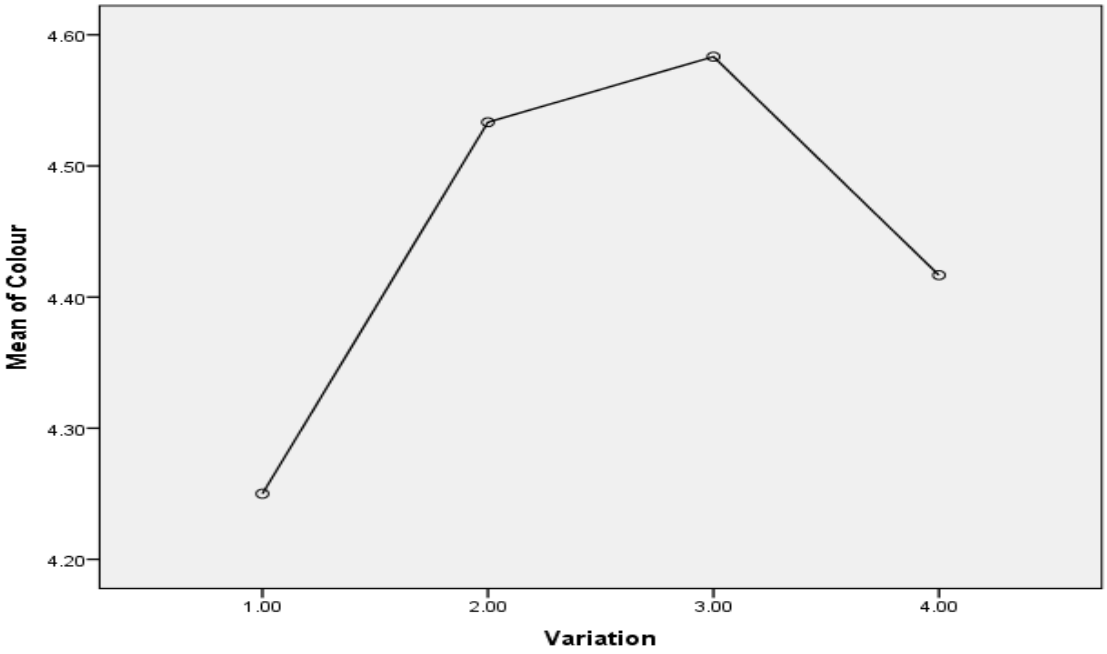
The above table represents the appearance scores for the vegan protein powder incorporated recipes. Among all the recipes variation 1 and variation 2(incorporated with 20 g of vegan protein powder) of all samples scored higher than variation 3(incorporated with 40g of vegan protein powder). While all the recipe variants 1 and 2 received high scores, variation 1 and variation 2 of Puttu received lower scores than the other 4 recipes in terms of appearance.

TABLE XIV

ACCEPTABILITY SCORE FOR THE COLOR CHARACTERISTICS

Table XIV indicates the scores for the color of all the vegan protein powder incorporated recipes in three variants.

	Puttu	**Chapati**	**Dosa**	**Bengal Gram Balls**	**Coconutmilk Milkshake**
Variation I	4.75±0.43	4.75±0.43	4.75±0.43	4.75±0.43	4.75±0.43
Variation II	4.75±0.43	4.75±0.43	4.75±0.43	4.75±0.43	4.75±0.43
Variation III	3.25±0.43	4±0.70	4.25±0.82	3.75±0.43	4.5±0.5



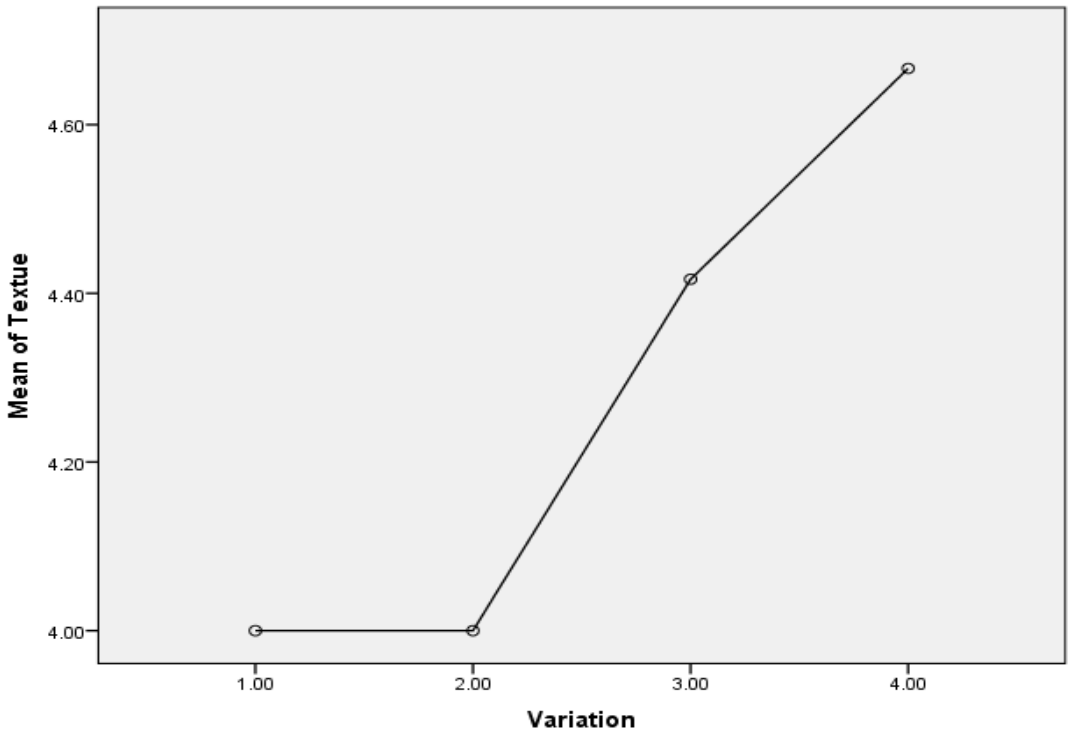
The above tablerepresents the colour scores for the vegan protein powder incorporated recipes. Variations 1 and 2(incorporated with 20 g of vegan protein powder) have the equal and highest score for all the five vegan protein powder incorporated recipes. Among Variation 3 recipes (incorporated 40 g of vegan protein powder) coconut milk milkshake scored higher and Variation 3 of Dosa and chapati followed more closely in terms of colour than the other two recipes. variation 3 of Puttu scored the least among the 5 different recipes and 3variations.

Table XVindicates scores for the texture of all the vegan protein powder incorporated recipes.

TABLE XV

ACCEPTABILITY SCORE FOR THE TEXTURE CHARACTERISTICS

	Puttu	**Chapati**	**Dosa**	**Bengal Gram Balls**	**Coconutmilk Milkshake**
Variation I	4.25±0.82	4±0.70	4.75±0.43	4.75±0.43	4.5±0.43
Variation II	4±0.70	4±0.70	4.75±0.43	4.75±0.43	4.5±0.43
Variation III	3.75±0.82	4±0.70	4.5±0.5	4.5±0.5	4.75±0.43



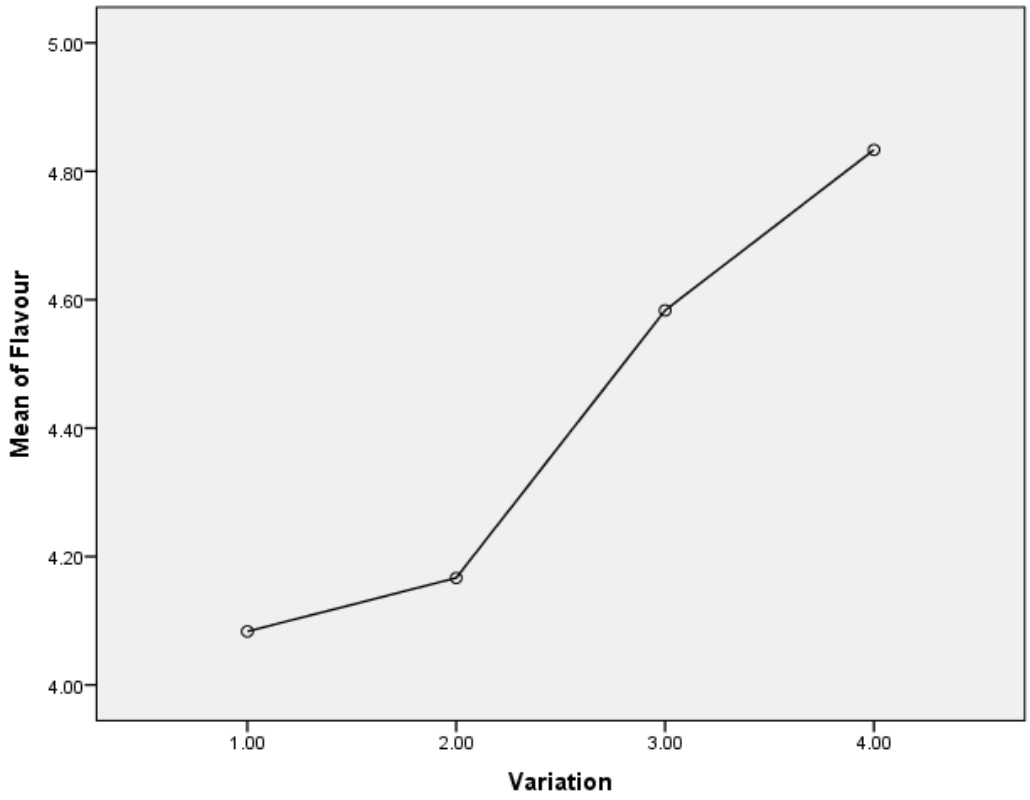
The above table represents the texture scores for the vegan protein powder incorporated recipes. Among the recipes prepared all 3 variations of chapati got the least scores in terms of texture. This was closely followed by all 3 variations of the Puttu got the second least score. All the 3 variations of dosa and Bengal gram balls and variation 3 of coconut milk milkshake scored higher than the other 2 recipes. Variation 3 of the Puttu recipe got the lowest score among all 5 items and 3 variations.

Table XVI reveals the acceptance scores of all the vegan protein powder incorporated recipes for flavour.

TABLE XVI

ACCEPTABILITY SCORE FOR THE FLAVOR CHARACTERISTICS

	Puttu	**Chapati**	**Dosa**	**Bengal Gram Balls**	**Coconutmilk Milkshake**
Variation I	4.5±0.5	4.25±0.43	4.75±0.43	5±0.00	4.5±0.5
Variation II	4.5±0.5	4.25±0.43	4.75±0.43	5±0.00	4.5±0.5
Variation III	3.5±0.5	4±0.70	4.5±0.5	4.75±0.43	5±0.00



The above table represents the flavour scores for the vegan protein powder incorporated recipes. Among the recipes prepared variation, 3 of Puttu got the least score in terms of flavour. This was closely followed by all variations of the chapati which got the second least score. All the 3 variations of Bengal gram balls and variation 3 of coconut milk milkshake scored higher than the other 3 recipes and all the 3 variations of Dosa scored the second-highest score.

Table XVII indicates the scores for the characteristic of taste of all the vegan protein powder incorporated recipes

TABLE XVII

ACCEPTABILITY SCORE FOR THE TASTE CHARACTERISTICS

	Puttu	**Chapati**	**Dosa**	**Bengal Gram Balls**	**Coconutmilk Milkshake**
Variation I	4.25±0.5	5±0.00	4.75±0.43	5±0.00	4.25±0.43
Variation II	4.25±0.43	5±0.00	4.75±0.43	5±0.00	4.75±0.43
Variation III	3.25±0.43	4± 0.70	4.75±0.43	5±0.00	5±0.00

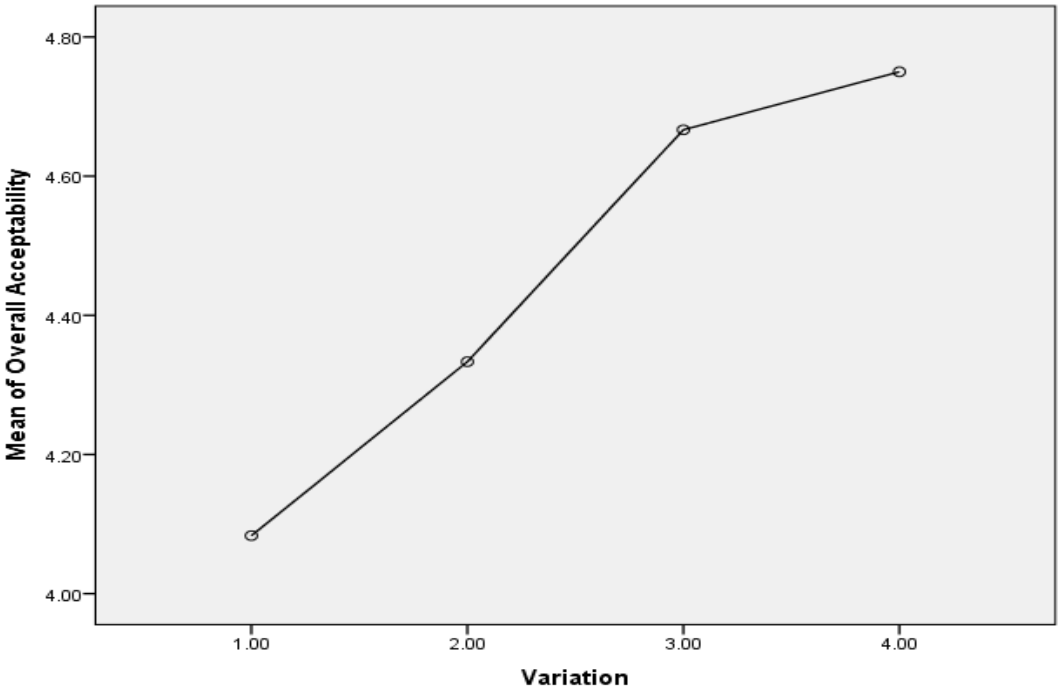
The above table represents the taste scores for the vegan protein powder incorporated recipes. Among the recipes prepared, all 3 samples of Bengal gram balls, variation 3 of coconut milk milkshake and variation1 and variation 2 of chapati scored higher than the other 2 recipes. This was closely followed by all 3 variations of dosa. With a score of 3.25, variation 3 of the Puttu got the least score in terms of taste.

Table XVIII represents the characteristic of overall acceptability of all the vegan protein powder incorporated recipes

TABLE XVIII

OVERALL ACCEPTABILITY SCORE OF VEGAN PROTEIN POWDER INCORPORATED RECIPES

	Puttu	**Chapati**	**Dosa**	**Bengal Gram Balls**	**Coconutmilk Milkshake**
Variation I	4.5±0.5	4.75±0.43	5±0.00	5±0.00	4±0.00
Variation II	4.5±0.5	4.75±0.43	4.75±0.43	5±0.00	4±0.00
Variation III	3.25±0.43	3.75±0.43	4.25±0.43	4.25±0.43	5±0.00



The above table depicts the overall acceptance of vegan protein powder formulated recipes. Among all the recipes prepared variation 1 and variation 2 of Bengal gram balls and variation 3 of coconut milk milkshake were highly accepted. This was closely followed by Variation 1 and variation 2 of chapati and variation 2 of Dosa. With scores of 3.25 variation, 3 of the Puttu got the least scores in terms of overall acceptance.

TABLE XIX

SUMMARY OF SENSORY EVALUATION OF ALL THE VEGAN PROTEIN POWDER INCORPORATED RECIPES

	Puttu	**Chapati**	**Dosa**	**Bengal Gram Balls**	**Coconutmilk Milkshake**
Appearance	4.08±0.72	4.33±0.52	4.66±0.38	4.75±0.43	4.66±0.14 ^{ad**}
Colour	4.25±0.86	4.53±0.46^{a*}	4.58±0.28 ^{ab*}	4.41±0.57^{ac**}	4.66±0.14
Texture	4.00±0.25	4.00±0.00	4.41±0.38^{ab**}	4.66±0.14^{ac**}	4.08±0.57
Flavor	4.08±0.52	4.16±0.28^{a**}	4.58±0.14	4.83±0.28^{ac**}	4.66±0.28 ^{ad**}
Taste	3.91±0.57	4.58±0.52 ^{a*}	4.83±0.14	5.00±0.00	4.66±0.28
Overall Acceptability	4.08±0.72	4.33±0.52	4.66±0.38	4.75±0.43	4.33±0.57 ^{ad**}

The above table reveals that in terms of Appearance, Variation of Bengal Gram Balls scored the maximum marks. This was closely followed by variations of coconut milk milkshake and Dosa. Similarly in terms of texture, again Bengal Gram Balls scored maximum with a score of 4.00, both Chapati and Puttu scored the least. In the case of taste, Puttu scored the least whereas Bengal Gram Balls scored the most. Overall Acceptability was found best in the case of Bengal Gram balls and closely followed by Dosa. Once again Puttu scored the least.

"To review values are mean ± SD of Puttu, Chapati, Dosa, and Bengal gram balls. ANOVA tests were used for comparison**.** 'a' denotesa significant difference at a 5% level between Puttu, Chapati, Dosa, Bengal gram balls and coconut milk milkshake, and 'b' denotes a significant difference at a 5% level between chapati and Dosa, 'c' denotes significant difference at 5% level between Chapati and Bengal gram balls". d' indicates a significant difference between chapatti and coconut milk milkshake at the 5% level.

PHASE IV: COLLECTION OF INFORMATION ON KNOWLEDGE OF VEGAN

Demographics of the selected subjects

The Women selected subjects (n=60) in the age group of 21-40 years were interviewed randomly within the general population through Google form. The demographic characteristics of selected subjects were presented in table XX.

TABLE XX

DEMOGRAPHIC PROFILE OF THE SELECTED SUBJECTS

Age (Years)	**Frequency**	**Percentage (%)**
21-30 years	45	75
31-40 years	15	25
Occupation		
Housewife	14	23.3
Student	31	51.7
Driver	2	3.3
Agricultural	2	3.3
Daily wager	2	3.3
IT	2	3.3
Teacher	2	3.3
Business	2	3.3
Financial consultant	1	1.7
Archagar	1	1.7
Courier office	1	1.7
Monthly income		
0-20,000	24	40.0
20,000-40,000	2	3.3
Above 40,000	34	56.7

According to Table XX, 75 percent of the selected subjects were between the ages of 21 - 30 years and 25 percent of the selected subjects were between the ages of 31-40 years of age. About 23.3 percent of the study population were housewives, 51.7% were students, 3.3 % each were drivers, farmers, daily wager, IT employees,

teachers, and business, 1.7 percent of them each were Financial consultants, Archagar and working in Courier office. The selected subjects with the income of 0 to 20,0000were 40%, 20,000 to 40,000 were 3.3% and Above 40,000 were 56.7%

Figure VI presented the diet pattern of the selected subjects

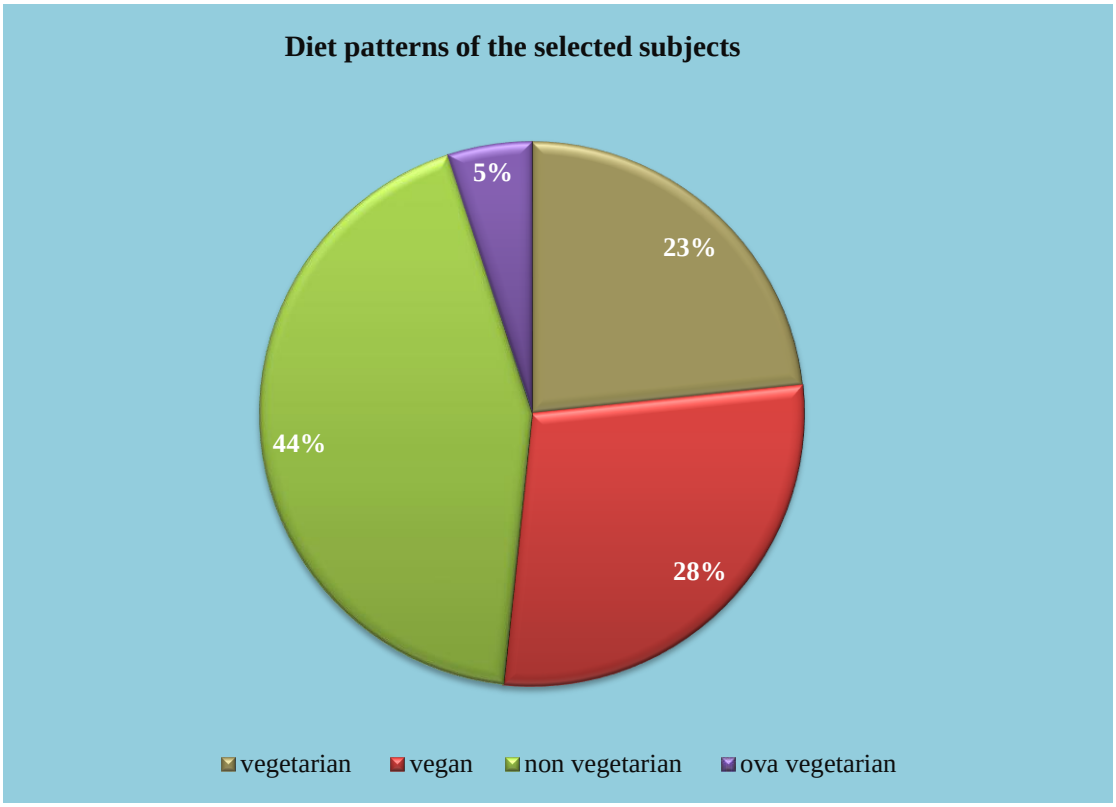


FIGURE VI

DIET PATTERN OF THE SELECTED SUBJECTS

From Figure VI, it was clear that among 60 selected subjects, the majority of the selected subjects were non-vegetarian (44%) followed by Vegan (28%), vegetarian (23%), and very few about 5% were Ova vegetarian.

Valente *et al* (2020) in the study reported that among 42 members of the study 18 members of the participants were nonvegetarian, 16 members of the participants were vegan, and 8 members of the participants were vegetarian.

Table XXI indicates the relationship between the knowledge on vegan protein powder available in the market and the current usage of vegan protein powder by the selected subjects.

TABLE XXI

RELATIONSHIP BETWEEN THE KNOWLEDGE ON VEGAN PROTEIN POWDER AVAILABLE IN THE MARKET AND CURRENT USAGE OF VEGAN PROTEIN POWDER BY THE SELECTED SUBJECTS

	r_p Value	P-value	N
Selected subject's knowledge on vegan protein powder available in the market vs Current usage of vegan protein powder by the selected subjects	-0.896*	0.017	60

*** r_p- Pearson's correlation** ***Correlation is significant at the 0.05 level (2-tailed)**

Table XXI shows that there was a negatively significant (p=0.017) association between the knowledge of the selected subjects about vegan protein powder available in the market and the current usage of vegan protein powder by the selected subjects of about 89%. This indicates that, though the selected subjects know about vegan protein powder available on market, they did not prefer to use vegan protein powder in their diet.

The study by Ujvari*et al* (2012) represents that among 284 sportspersons 33.6% of selected subjects were vegans and 36% of selected subjects were vegetarians.They had consumed the plant-based protein powder available in the market.

Table XXII indicates the relationship between the knowledge about vegan protein powder available in the market and the selected subjects who tried making vegan protein powder at home

TABLE XXII

RELATIONSHIP BETWEEN THE KNOWLEDGE ABOUT VEGAN PROTEIN POWDER AVAILABLE IN THE MARKET AND THESELECTED SUBJECTSWHO TRIED MAKING VEGAN PROTEIN POWDER AT HOME

	r_p Value	P-value	N
Vegan based protein powder available in the market VS selected subjects tried making vegan protein powder at home	0.427	0.014	60

*** r_p- Pearson's correlation** ***Correlation is significant at the 0.05 level (2-tailed)**

From table XXII, it was clear that there was a positively significant ($p<0.001$) association between the knowledge of selected subjects about vegan protein powder available in the market and the selected subjects who tried making vegan protein powder at the home of about 42% of the selected subjects. Even though the selected subjects know about vegan protein powder available in the market, they tried making vegan protein powder at the home itself.

Table XXIII indicates the relationship between the current usage of protein powder and on what basis they primarily use protein powder by the selected subjects.

TABLE XXIII

THE RELATIONSHIP BETWEEN THE CURRENT USAGE OF PROTEIN POWDER AND ON WHAT BASIS DO THEY PRIMARILY USE PROTEIN POWDER BY THE SELECTED SUBJECTS

	$r_p$value	**P-value**	**N**
Current usage of Vegan protein powder by the selected subjects VS on what basis do they primarily use protein powder	0.802	0.033	60

*** r_p- Pearson's correlation *Correlation is significant at the 0.05 level (2-tailed)**

From table XXIII, it was clear that there was a positively significant ($p<0.001$) association between the current usage of vegan protein powder by the selected subjects and on what basis do they primarily use a protein powder about 80% of the selected subjects which indicates that the selected subjects didn't currently use vegan protein powder in their diet.

Table XXIV indicates the relationship between the frequency of protein-rich food consumption and the selected subject‘s source of protein consumption

TABLE XXIV

RELATIONSHIP BETWEEN THE FREQUENCY OF PROTEIN-RICH FOOD CONSUMPTION AND THESELECTED SUBJECT'S SOURCE OF PROTEIN CONSUMPTION

		Selected subject's source of protein consumption						
		Only Food protein	**Majority of food protein & fewer supplements**	**Balanced between food and supplement**	**More protein supplements**	**Total**	**X^2**	**P-Value**
The frequency of selected subjects consuming protein foods	Daily	31	6	0	2	39	25.569[a]	0.002
	Weekly	14	3	0	0	17		
	Monthly	2	0	1	0	3		
	Occasionally	0	1	0	0	1		
	Total	**47**	**10**	**1**	**2**	**60**		

Table XXIV indicates that there was a significant ($p<0.05$) relationship between the frequency of protein-rich food consumption and the selected subject's source of protein consumption, (X^2 (1) = 25.669[a], $p<0.05$). The majority of the selected subjects consumed proteins daily only through their food and only 2 selected subjects consumed more supplements than food for their protein.

Table XXV shows the association between the knowledge of the selected subjects about the vegan effect on weight loss and do vegans get sufficient protein.

TABLE XXV

ASSOCIATION BETWEEN THE KNOWLEDGE OF THE SELECTED SUBJECTSABOUT VEGAN EFFECT ON WEIGHT LOSS AND DO VEGANS GET SUFFICIENT PROTEIN

		Vegans get sufficient protein						
		Definitely Not	**Not sure**	**Probably**	**Definitely**	**Total**	**X^2**	**P-Value**
Vegan effect on weight loss	No	0	2	0	1	3	6.635[a]	0.675
	Yes	8	9	11	2	30		
	May be	6	5	10	1	22		
	Not sure	0	1	4	0	5		
	Total	**14**	**17**	**25**	**4**	**60**		

Table XXV indicates that there was a significant ($p<0.05$) association between the Knowledge of the selected subjects about the vegan effect on weight loss and the selected subject's awareness of the quantity of protein in vegan foods (X^2 (1) = 6.635[a], $p<0.05$). Only 8 selected subjects said that vegans lose weight, and one respondent said that vegans get sufficient protein.

Turner *et al* (2012) in the study concluded that vegan group participants (n= 31) lose more weight compared to NCEP group participants (n=31). The vegan group participants lost approximately 7.5% of their body weight.

It highlights that majority of the selected subjects (n=31) were clear that the quantity of protein in vegan food is not enough, 25 members of the selected subjects were not sure of the quantity of proteins in vegan food only 3 % of the selected subjects said that a vegan probably gets enough protein.

Figure VII represents the consumption of protein-rich foods by selected subjects

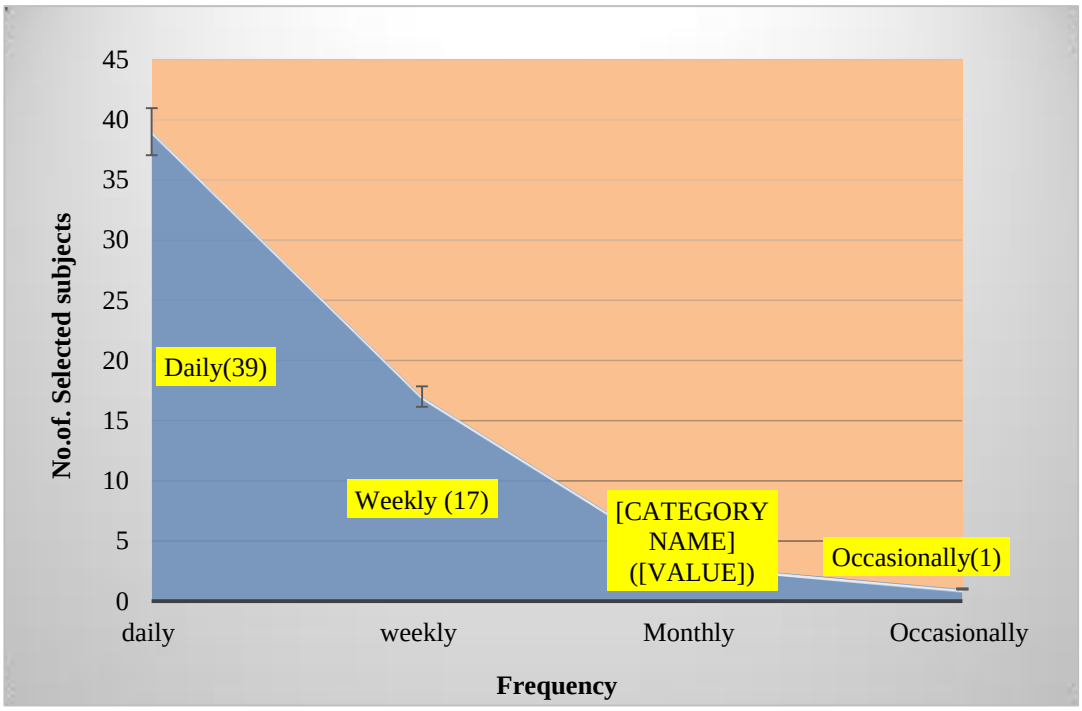


FIGURE VII

CONSUMPTION OF PROTEIN-RICH FOODS BY SELECTED SUBJECTS

From Figure VII, it was clear that nearly 39 selected subjects consumed protein-rich foods daily, 17 selected subjects consumed protein-rich foods weekly, 3 selected subjects consumed protein-rich foods monthly and only one selected subject consumed protein-rich food occasionally.

The study by Vijay *et al* (2020) reported that 23% of the female selected subjects consumed protein daily, 18% of the female selected subjects consumed protein-rich foods weekly, and 14% of the selected subjects consumed protein-rich foods occasionally.

Table XXVI indicates the relationship between the nutritional quality of vegan foods and the current usage of vegan protein powder by the selected subjects

TABLE XXVI

RELATIONSHIP BETWEEN THE NUTRITIONAL QUALITY OF VEGAN FOODS AND THE CURRENT USAGE OF VEGAN PROTEIN POWDER BY THE SELECTED SUBJECTS

	r_p value	**P-value**	**N**
Vegan food is nutritious VS current usage of vegan-protein powder	-0.652	0.059	60

*** r_p- Pearson's correlation** ***Correlation is significant at the 0.05 level (2-tailed)**

Table XXVI shows the negatively significant (p=0.059) relation between the nutritional quality of vegan foods and the current usage of vegan protein powder by about 65% of the selected subjects. This indicates that though the selected subjects were aware that vegan food is nutritious, they did not consume vegan protein to maintain a healthier life.

Mamina and Mazirir*i et al* (2021) in the study examined the young people's interest in a vegan diet. He stated that 50% of people prefer a vegan diet. A vegan diet provides long-term good health, 35% of people prefer a vegan diet because the vegan diet is healthier than nonveg foods 15% of people preferred vegan food because they felt that was safe and nutritious.

Table XXVII association between the Knowledge of the selected subjects about the effect of vegan on hormones and effect of vegan on weight loss

TABLE XXVII

ASSOCIATION BETWEEN THE KNOWLEDGE OF THE SELECTED SUBJECTSABOUT EFFECT OF VEGAN ON HORMONES AND EFFECT OF VEGAN ON WEIGHT LOSS

		Selected subjectsaware of the effect of vegan on weight loss						
		No	**Yes**	**Not sure**	**Maybe**	**Total**	**X^2**	**P-Value**
Knowledge of selected subjects about the effect of vegan on hormones	No	0	9	5	2	16	11.608a	0.236
	Yes	3	10	2	0	15		
	May be	0	6	8	1	15		
	Not sure	0	5	7	2	14		
	Total	**3**	**20**	**22**	**5**	**60**		

Table XXVII indicates that there was a significant ($p<0.05$) association between the Knowledge of selected subjects about the vegan effect on hormone levels and the vegan effect on weight loss ($X2(1) = 11.608^{a}$, $p<0.05$).

It was clear that 3 % of the selected subjects said that a vegan diet affects hormones and 9% of the selected subjects said that a vegan diet affects weight loss

Table XXVIII indicates the knowledge of selected subjects on distinction between a vegan and a vegetarian and whether everyone can be vegan

TABLE XXVIII

KNOWLEDGE OF THE SELECTED SUBJECTS ON DISTINCTION BETWEEN A VEGAN AND A VEGETARIAN AND WHETHER EVERYONE CAN BE VEGAN

	rp value	P-value	N
Knowledge of selected subjects about the distinction between a vegan and a vegetarian VS whether everyone can be vegan	0.106	0.420	60

Table XXVIII highlights the significant (P<0.01) association between the distinction between a vegan and a vegetarian and whether everyone can be vegan for about 10% of the selected subjects. This indicates that the selected subjects are aware of the difference between vegan and vegetarian and also possible for everyone to be vegan.

Figure VIII, selected subject's knowledge of the selected subjects aboutvegan foods meets daily protein requirements

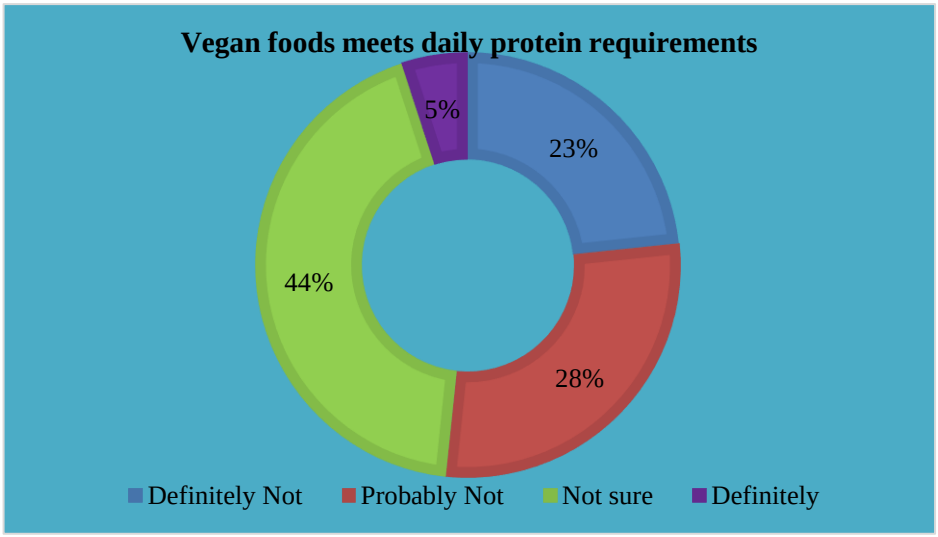


FIGURE VIII

KNOWLEDGE OF THE SELECTED SUBJECTS ABOUTVEGAN FOODS MEETS DAILY PROTEIN REQUIREMENTS

aware of the quantity of proteins in vegan food and finally a least number of 5 % of the selected subjects said that the quantity of protein in vegan food is enough.

Mariotti and Gardner (2012) in the study concluded that a vegan diet provides more protein so that vegans get enough protein by consuming various nuts, soya, wheat, pulses, legumes, cereals, and Millets.

Table XXIX indicates the relationship betweenknowledge about some plant-based protein-rich foods and familiarity with vegan protein powders

TABLE XXIX

RELATIONSHIP BETWEEN THE KNOWLEDGE ABOUT SOME PLANT-BASED PROTEIN-RICH FOODS AND FAMILIARITY WITH VEGAN PROTEIN POWDERS

	rp value	**P-value**	**N**
Plant-based protein-rich foods VS familiar with vegan protein powders	-0.887	0.019	60

*** r_p- Pearson's correlation** ***Correlation is significant at the 0.05 level (2-tailed)**

Table XXIX shows that negatively significant(P=0.019) relation between some plant-based protein-rich foods and familiarity with vegan protein powders of about 88% of the selected subjects. This indicates that they were not aware of plant-based protein-rich foods and they were not familiar with vegan protein powder.

Table XXX indicates the relationship between familiarity with vegan protein powder and preference among whey protein or vegan/plant-based protein powders.

TABLE XXX

RELATIONSHIP BETWEEN THE FAMILIARITY WITH VEGAN PROTEIN POWDER AND PREFERENCE AMONG WHEY PROTEIN OR VEGAN/PLANT-BASED PROTEIN POWDERS

	rp value	**P-value**	**N**
Familiar with vegan protein powders VS prefer whey protein or vegan protein powders	-0.726	0.046	60

*** r_p- Pearson's correlation** ***Correlation is significant at the 0.05 level (2-tailed)**

From Table XXX, it was clear that there was a negatively significant (p=0.046) association between familiarity with vegan protein powder and preference among whey protein or plant-based protein of about 72% of the selected subjects. Even though the selected subjects were not familiar with vegan protein powders they preferred vegan protein powder.

Table XXXI indicates the relationship betweenthe selected subject's familiarity with vegan protein powder and how the selected subjects came to know about vegan protein powder.

TABLE XXXI

RELATIONSHIP BETWEEN THE SELECTED SUBJECT'SFAMILIARITY WITH VEGAN PROTEIN POWDER AND HOW THE SELECTED SUBJECTSCAME TO KNOW ABOUT VEGAN PROTEIN POWDER

	rp value	**P-value**	**N**
Familiar with vegan protein powders VS how did the selected subjects came to know about vegan protein powder	-0.685	0.000	60

*** r_p- Pearson's correlation *Correlation is significant at the 0.05 level (2-tailed)**

From table XXXI, it was clear that there was a negatively significant (p=0.000) association between familiarity with vegan protein powder and how the selected subjects came to know about vegan protein powder. Even though the selected subjects hear about vegan protein powder they were not familiar with vegan protein powder.

Table XXXII association between the knowledge of the selected subjects about the price of the vegan food and whether vegan diet is healthy and nutritional.

TABLE XXXII

KNOWLEDGE OF THE SELECTED SUBJECTSABOUT THE PRICE OF THE VEGAN FOOD AND WHETHER THE VEGAN DIET IS HEALTHY AND NUTRITIONAL

		Knowledge of selected subjectsabout whether the vegan diet is healthy and Nutritional					
		No	**Yes**	**Maybe**	**Total**	**X^2**	**P-Value**
Knowledge of selected subjects about the price of the vegan foods	No	3	18	4	25	14.648 [a]	0.023
	Yes	3	10	1	14		
	May be	1	5	7	13		
	Not sure	0	.	5	8		
	Total	**7**	**36**	**17**	**60**		

Table XXXII indicates that there was a significant ($p<0.05$) association between the price of the vegan food and whether vegan diet is healthy and nutritional, ($X2(1) = 14.684^a$, $p<0.05$). 27% of the selected subjects were clear that vegan food is expensive and 53% of the selected subjects said that vegan food is both healthy and nutritionally complete.

Table XXXIII indicates the relationship between the selected subject's knowledge about healthful and nutritional quality of a vegan diet and whether it is ok to eat already prepared vegan alternatives.

TABLE XXXIII

RELATIONSHIP BETWEEN THESELECTED SUBJECTSKNOWLEDGE ABOUT HEALTHFUL AND NUTRITIONAL QUALITY OF VEGAN DIET AND WHETHER IT IS OK TO EAT ALREADY PREPARED VEGAN ALTERNATIVES

	rp value	**P-value**	**N**
Healthful and nutritional quality of vegan diet VS whether it is ok to eat some of the vegan alternatives that are already prepared	0.469	0.000	60

*** r_p- Pearson's correlation** ***Correlation is significant at the 0.05 level (2-tailed)**

From table XXXIII, it was clear that positively significant (p=0.000) association between is the healthy and nutritional quality of a vegan diet and whether it is ok to eat already prepared vegan alternatives. The selected subjects said that the vegan diet is nutritionally complete as well as healthy and also ready to eat vegan products are also good to eat.

Figure IX shows the knowledge of the selected subjects on the need of special diets for protein absorption among vegans.

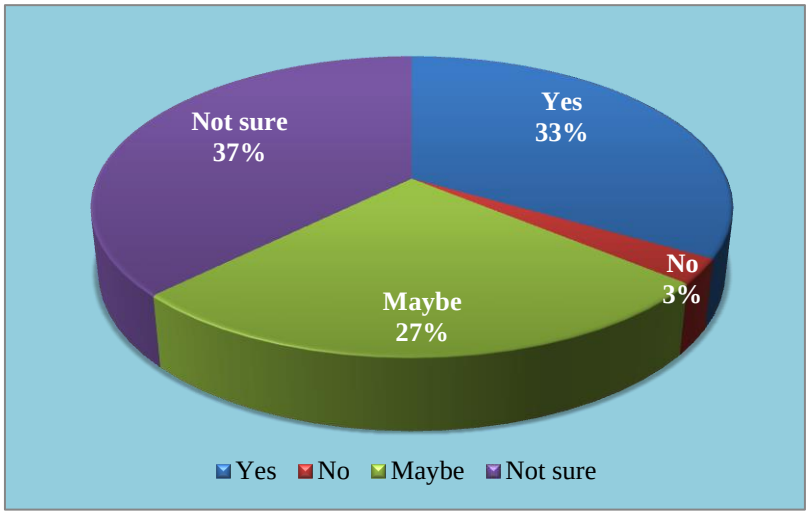


FIGURE 1X

NEED OF SPECIAL DIETS FOR PROTEIN ABSORPTION AMONG VEGANS

Figure IX highlights that 60% of the selected subjects said that vegans need to consume special foods to absorb protein, 37% of the selected subjects were not aware of the concept of protein absorption, and 3% of the selected subjects said that vegans do not need special foods for protein absorption.

Table XXXIV indicates the relationship between the selected subjects whoever tried making vegan protein powder at home and selected subjects who are ready to suggest vegan protein powder to others.

TABLE XXXIV

RELATIONSHIP BETWEEN THE SELECTED SUBJECTS WHOEVER TRIED MAKING VEGAN PROTEIN POWDER AT HOME AND SELECTED SUBJECTS WHO ARE READY TO SUGGEST VEGAN PROTEIN POWDER TO OTHERS

		Will you suggest vegan protein powder to others						
		Definitely	**Probably**	**Not sure**	**Definitely Not**	**Total**	**X^2**	**P-Value**
Selected subjects whoever tried making vegan protein powder	No	8	12	12	2	34	15.167[a]	0.056
	Yes	5	2	6	5	18		
	Not sure	0	3	5	0	8		
	Total	**13**	**17**	**23**	**7**	60		

Table XXXIV indicates that there was a significant ($p<0.05$) association between the selected subjects whoever tried making vegan protein powder at home and selected subjects who suggest protein powder to others ($X2(1) = 15.167^a$, $p<0.05$). It was clear that among 60 selected subjects 8% the selected subjects never tried making vegan protein powder at home and only 2 % of the selected subjects will not suggest vegan protein powders.

Table XXXV association between the knowledge of the selected subjects about the current usage of vegan protein powder and vegan protein powder intake for a long time creates an adverse or ill effect.

TABLE XXXV

KNOWLEDGE OF THE SELECTED SUBJECTS ABOUT THE CURRENT USAGE OF VEGAN PROTEIN POWDER AND VEGAN PROTEIN POWDER INTAKE FOR A LONG TIMECREATE ADVERSE OR ILL EFFECTS

Current usage of vegan protein powder		**Knowledge of selected subjectsabout vegan protein intake for a long time will create the adverse or ill effect**						
		Definitely	**Probably**	**Not sure**	**Definitely Not**	**Total**	**X^2**	**P-Value**
Use it regularly	No	3	1	0	4	10	4.093[a]	0.664
Use it only sometimes	Yes	4	1	4	4	13		
Have never used it	Not sure	10	4	10	13	37		
	Total	**17**	**8**	**15**	**21**	**60**		

Table XXXV indicates that there was a significant ($p<0.05$) association between the knowledge about the current usage of vegan protein powder and Vegan protein powder intake for a long time creating adverse or ill effects, ($X2(1) = 4.093a$, $p<0.05$). Among all the 60 selected subjects, only 1 selected subject said that vegan intake for a long time will create adverse or ill effects and 10 selected subjects have never used vegan protein powder in their diet.

PHASE V: CREATION OF AWARENESS ON VEGAN PROTEIN POWDER AMONG SELECTED SUBJECTS

The Awareness session was imparted to 60 women in the age group of 21-40 years on the developed Vegan Protein Powder.

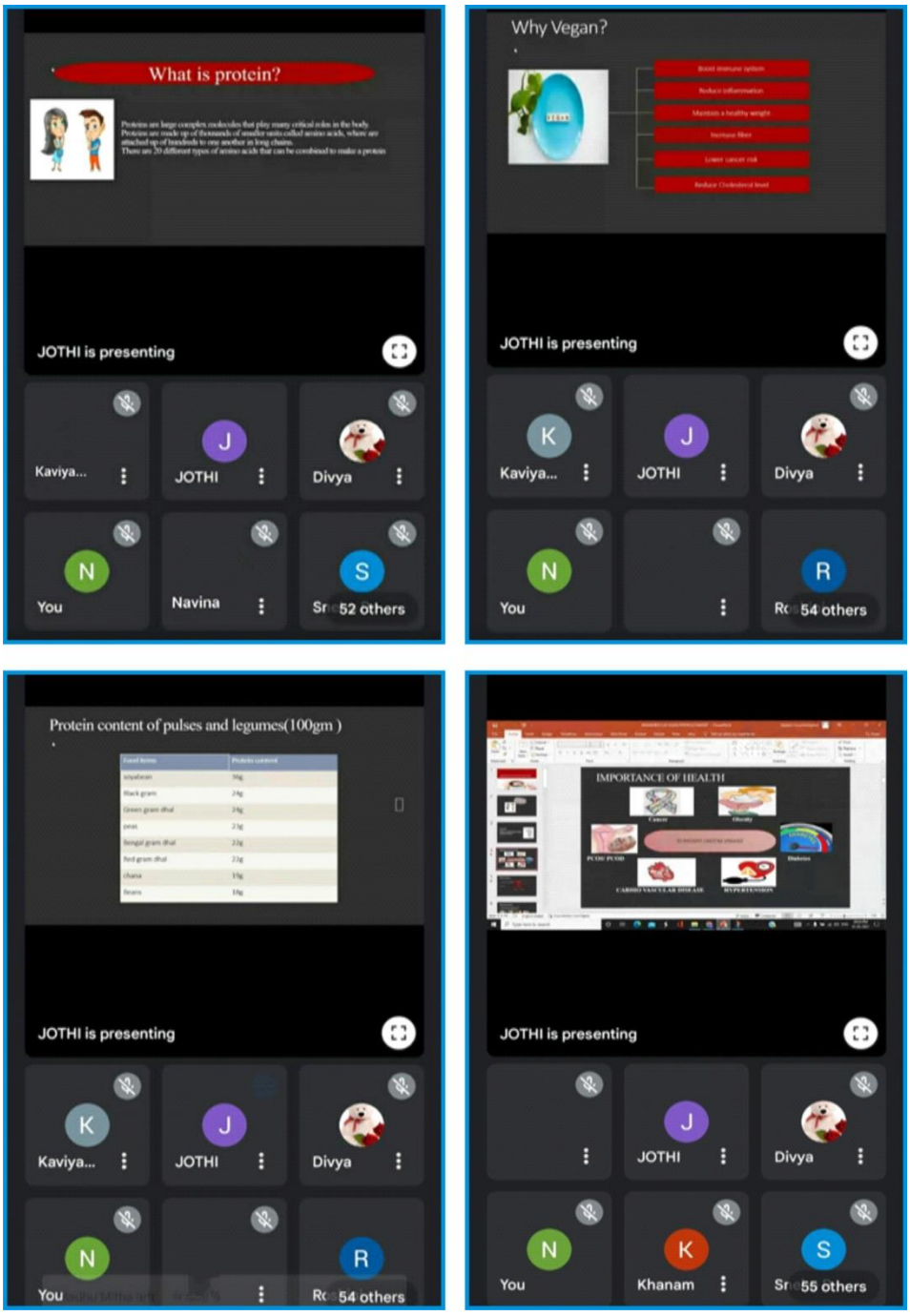


PLATE XII

CREATION OF AWARENESS ON DEVELOPED VEGAN PROTEIN POWDER AMONG SELECTED SUBJECTS

V SUMMARY AND CONCLUSION

The study titled ***"Development of Vegan Protein Powder and Its Quality Analysis"*** was conducted in four phases to determine the best method to develop Vegan Protein Powder, Formulation of vegan protein powder products and study the knowledge of women on vegan protein powder and the importance of protein.

Beginning with the goal of developing something to help people with protein deficiencies, particularly in the poorer sections of society, this research has resulted in the creation of a protein supplement made from easily available ingredients.

The powder developed was vegan as it is free from any animal sources. Plant-based Powder is also called vegan powder. It's nothing but the powder extracted from the plant sources. The vegan powder can be extracted from different groups like cereals (black rice & oats), pulses and legumes (Green gram, Soybean &Peas), nuts and seeds (Peanuts, coconuts, almond, sesame & flax). This type of powder is less in cholesterol, lactose-free and rich in other nutrients like protein, carbohydrates, vitamins and minerals. Vegan or plant-based powder is used to prepare various products like Dosa, chapati, puttu, milkshakes, etc.

Vegan Protein powder is developed for people who are not able to take whey protein or any animal sources due to reasons like veganism, lactose intolerance, dislike of milk and milk products and to prevent protein deficiencies among vegans and vegetarians. Veganism is eating only plants and plant-based products. Others can also try vegan Protein powder to add variety to their diet, which increases the intake of plant-based nutrients. Vegan protein can aid in post-workout recovery and muscle mass maintenance.

Pulses and Legumes are a low-cost and sustainable source of protein, unsaturated fat, dietary fiber, low-glycemic carbohydrates, micronutrients, and essential bioactive phytochemicals and are cholesterol-free. A diet high in animal products and low in plant food sources is the cause of many lifestyle diseases. Legumes have low fat and high dietary fiber content. A protein combination of pulses and legumes was designed to assist in achieving the protein requirements.

Development of Vegan Protein Powder

- Ingredients selected for phase I of the study were pulses and legumes such as Green gram (Vigna radiata), Peas *(Pisum sativum),* Black Gram Dal *(Vigna mung), and* Soybean *(Glycine max).*
- Green gram is high in essential amino acids like phenylalanine, leucine, isoleucine, valine, lysine, and arginine, as well as prebiotic and nutraceutical qualities. Pea protein is abundant in arginine, an amino acid that aids in the formation of muscle-building creatine, which aids in muscle repair. Black gram is a high-protein, high-fiber food that aids in weight gain, boosts immunity, and improves muscle fiber. Soy protein is an important part of the diet since it contains more lysine than wheat proteins assisting in the prevention of cancer, obesity, diabetes, and kidney disease.
- The selected pulses and legumes were processed through different methods such as cleaning, sun drying, dry roasting, pulverizing, and sieving for extraction of vegan protein powder.

Represent the Variations of Developed Vegan Protein Powder

- The vegan protein powder was developed into three different compositions such as C1, C2 and C3. The developed powder was evaluated for sensory attributes using a five-point hedonic scale by four members.
- The sample that was accepted as the best was C3. This sample included 30g of the Green gram, 25 of peas, 15g of Black Gram dal and 30g of Soybean. This helped finalize C3 as the most acceptable and liked the sample.
- The isolation of protein was done from the developed vegan protein powder and its nutrient and shelf-life analysis were performed.

Formulation of Vegan Protein Powder Incorporated Recipes

- The sample C3 was utilized to prepare various vegan protein powder incorporated products such as Puttu, Chapati, Dosa, Bengal gram balls, and coconut milk milkshake.
- The overall acceptability score was significantly higher for Bengal Gram Balls which had an overall score of 4.75±0.43 and followed by Dosa, with an overall score of 4.66±0.38.

- Puttu scored the least overall acceptability score in all variations which had an overall score of 4.08±0.72.

Assessment of the Level of Knowledge on Vegan Protein Powder and Creation of Awareness

- As a part of the study, the level of knowledge on vegan protein powder and its importance was assessed for the selected 60 women between the age of 21-40 years.
- An E-questionnaire was developed and shared as a google form for the selected subjects and it consisted of demographic profile and knowledge of the selected subjects towards vegan protein powder consumption. The collected data were then pooled and interpreted with the help of SPSS software.
- From the data, it was revealed that there was a significant association between the consumption of protein-rich foods and knowledge of vegan protein powder. It was clear that 42% of the selected subjects knew about the availability of vegan protein powder on market.
- In the case of protein requirements, only 5% of the selected subjects said that vegan foods meet the daily protein requirement.
- Data shows that there is a positive significant relationship between the respondent's knowledge about vegan protein powder available on market and selected subjects who tried making vegan protein powder at home. Around 42 percent of selected subjects tried making vegan protein powder at home.
- In view of the distinction between vegan and vegetarian, 10 percent of selected subjects knew the difference.
- Study selected subjects were now aware of the plant-based protein-rich foods and vegan protein powder effect on hormones.
- Data shows that there is a positive significant relationship between the respondent's knowledge about the healthful and nutritional quality of a vegan diet and is it ok to eat already prepared vegan alternatives. Around 46 percent of selected subjects were aware of the healthful and nutritional quality of vegan foods.
- An education material on the awareness of vegan protein powder was developed as a PowerPoint and shared with the selected subjects.

- Post-knowledge data depicts that most of the selected subjects who were not aware of the vegan protein powder were come to know about it after the awareness session with prepared education material.

Conclusion

Therefore, it was found that vegan protein powder derived from pulses and legumes can be acceptable by using the processing techniques. Daily intake of vegan protein powder helps to meet the protein requirement among vegans and vegetarians. And it is important to know the benefits of vegan protein powder. The developed vegan protein powder was incorporated into various recipes such as Puttu, Chapati, Dosa, Bengal gram balls and almond and Coconut milk Milkshakes and sensory evaluation was performed in terms of appearance, taste, color, flavor, and texture. The vegan protein powder can also be incorporated in various ways including mixing with Dosa batter, Chapati dough, Vada batter, Milkshakes, Baking, Kolukattai, Murukku mix, Porridge, Ladoo, Halwa, Cutlet, Sandwich, Aloo paratha, Curries, etc.

The isolated protein powder was high in protein content whereas low in carbohydrate and fat content. The study created awareness for the selected adult women and enabled them to know about some plant-based protein-rich foods and highlights the importance of the intake of vegan protein powder. Thus, this study was effective in increasing the consumption rate of plant-based protein powder. Also, the study motivates the public to become an entrepreneur. A new idea like this doesn’t require much investment and enables them towards creating a healthy society. If well-executed, the marketing of pulses protein as a vegan source has a promising future.

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ANNEXURE - I

Institutional Human Ethical Clearance Certificate

INSTITUTIONAL HUMAN ETHICS COMMITTEE

Avinashilingam

Institute for Home Science and Higher Education for Women
(Deemed to be University under Category 'A' by MHRD, Estd. u/s 3 of UGC Act 1956) Re-accredited with 'A++' Grade by NAAC.
Recognised by UGC Under Section 12 B
Coimbatore-641 043, Tamil Nadu, India

Chairman
Dr.Sudha Ramalingam
Director-Research & Innovation,
Professor-Community Medicine,
PSG Institute of Medical Sciences & Research, Coimbatore

Member Secretary
Dr.S.Uma Mageshwari
Professor and Head,
Department of Food Service Management & Dietetics

Members
Mr.K.Arunmoli (Legal Expert)
Dr.Subhashini K. Sripathi
Dr.A.Saraswathy (Medical Officer)
Ms.D.Kavitha
Dr.A.R.SudamaniRamasamy
Dr.G.Victoria Naomi
Dr. Judith Justin
Dr.AnithaSubash

24th March 2022

To
Ms.Nalasri.P
Department of Food Service Management and Dietetics
Avinashilingam Institute for Home Science and
Higher Education for Women
Coimbatore – 641 043

Dear Nalasri.P,

Ref: Your proposal No. IHEC/21-22/FSMD-19 entitled "Development of Vegan Protein Powder and Its Quality Analysis" resubmitted for approval to IHEC on 18.03.2021.

The Institutional Human Ethics Committee of our University hereby grants approval to your research proposal No. IHEC/21-22/ FSMD-19 entitled "Development of Vegan Protein Powder and Its Quality Analysis" resubmitted by you. The Approval number for the same is AUW/IHEC/FSMD-21-22/XMT-19.

We wish you all the best in your research endeavours.

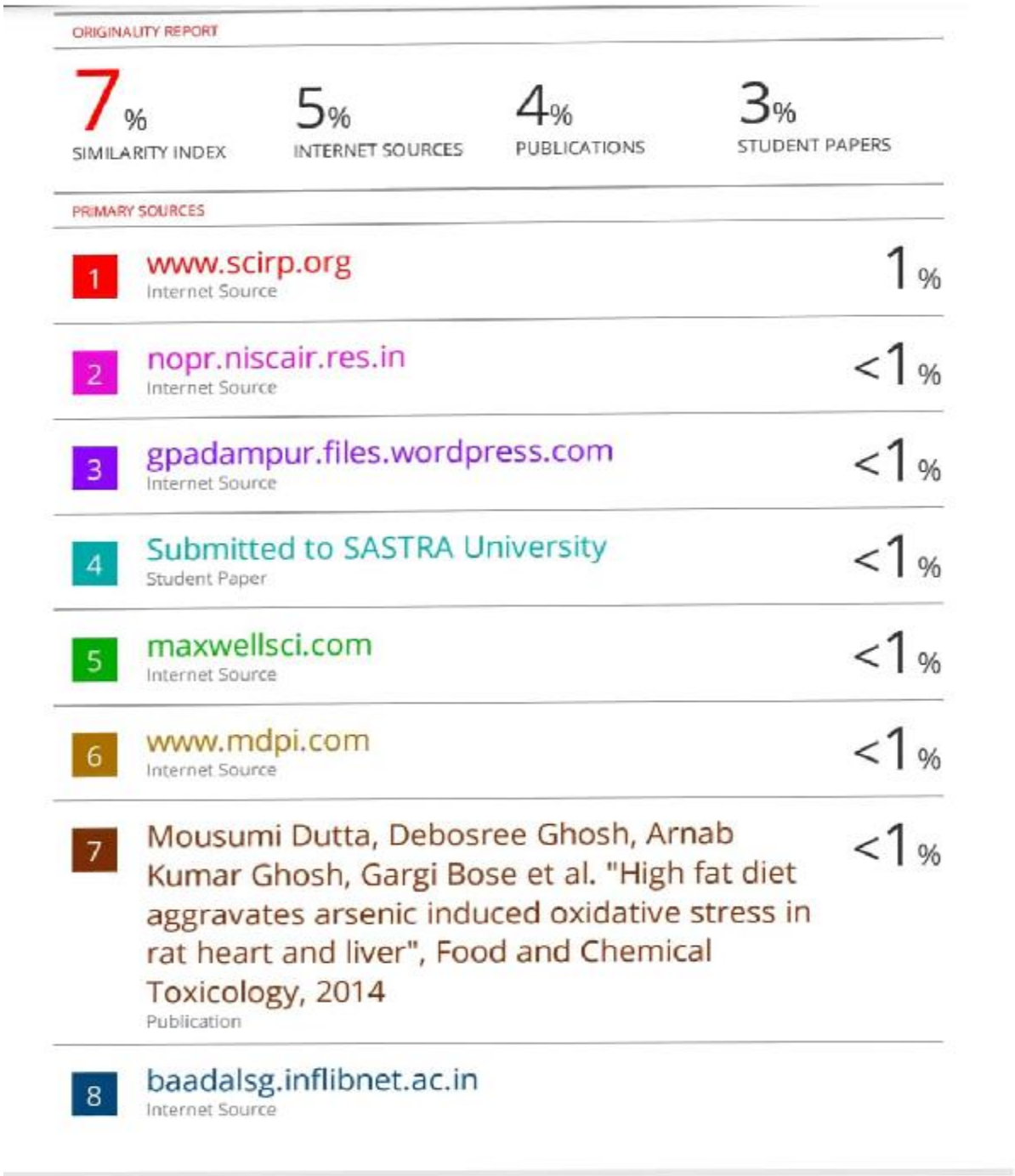
Regards,

S. Uma Mageshwari
Dr.S.Uma Mageshwari
Member Secretary

Institutional Human Ethics Committee

ANNEXURE – II

PLAGIARISM REPORT



ORIGINALITY REPORT

7%	5%	4%	3%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

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3	gpadampur.files.wordpress.com Internet Source	<1%
4	Submitted to SASTRA University Student Paper	<1%
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6	www.mdpi.com Internet Source	<1%
7	Mousumi Dutta, Debosree Ghosh, Arnab Kumar Ghosh, Gargi Bose et al. "High fat diet aggravates arsenic induced oxidative stress in rat heart and liver", Food and Chemical Toxicology, 2014 Publication	<1%
8	baadalsg.inflibnet.ac.in Internet Source	

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ANNEXURE - III

E-Questionnaire to Elict Data on Demographic Profile and Awareness on Vegan Protein Powder

Name :

Age :

Gender :

Address :

Occupation :

Monthly income : ☐ 0-20,000 ☐ 20,000 - 40,000 ☐ above 40,000

Knowledge on vegan protein powder

1. Which of the following best describes your diet?

   ☐ Vegetarian ☐ Vegan ☐ Non vegetarian ☐ Ova vegetarian

2. How often you consume protein rich foods?

   ☐ Daily ☐ Weekly

   ☐ Monthly ☐ Occasionally

3. What is the source of protein in your diet?

   ☐ Food protein

   ☐ Mostly food protein with some supplements

   ☐ Fairly balanced between food protein and supplements

   ☐ More protein supplements than food proteins

   If you use protein supplements, what kind of supplements?

4. How much protein should you consume on a daily basis?

5. What does veganism based on

   ☐ Milk and Milk based products

   ☐ Plant and plant-based products

   ☐ None of the above

6. Do you know some plant -based protein rich foods?

   ☐ Yes ☐ No

   ☐ Not sure ☐ Maybe

   If yes, what are they?

7. How familiar are you with vegan/ plant based protein powders

   ☐ I am aware of it ☐ I have never heard of it

8. Do you prefer vegan/plant based protein powders

   ☐ whey protein ☐ Vegan/ plant based protein

9. If you aware, how you first came to know about vegan protein powder

   ☐ Tv ☐ Radio

   ☐Magazine ☐ Newspaper

   ☐Internet ☐Friend/ Relative/ Associate

   ☐Not sure

10. Do you know the distinction between of vegan and vegetarian?

    ☐ Yes ☐ No

    ☐ Maybe ☐ Not sure

    If yes, what are they?

11. Do you think vegan food is nutritious?

    ☐ Definitely ☐ Probably

    ☐ Not sure ☐ Definitely Not

12. What type of vegan dishes can be prepared at home?

13. Where can you find vegan alternatives to all animal products?

14. Is vegan food more expensive than non veg foods?

    ☐Yes ☐ No

    ☐ May be ☐ Not sure

15. Is it possible to eat vegan diet that is both healthy and nutritional?

    ☐ Yes ☐ No

    ☐ May be ☐ Not sure

16. Is it ok to eat some of the vegan alternatives that are already prepared?

    ☐ Yes ☐ No

    ☐ May be ☐ Not sure

17. Is it possible for everyone to be vegan?

    ☐ Yes ☐ No

    ☐ May be ☐ Not sure

18. What is the best way for vegans to receive enough nutrients?

19. Is it true that being vegan has an effect on hormones?

☐ Yes ☐ No

☐ May be ☐ Not sure

20. Is it true that vegan diet can help you lose weight?

☐ Yes ☐ No

☐ May be ☐ Not sure

21. People claim that because vegetarians don't consume meat, they don't receive enough protein in their diets, Is this correct?

☐ Definitely Not ☐ Probably Not

☐ Not sure ☐ Probably

☐ Definitely

22. Is it true in order to absorb protein, vegetarians must combine particular foods?

☐ Yes ☐ No

☐ May be ☐ Not sure

23. Do you know any vegan/plant-based protein powder available in market?

☐ Yes ☐ No

☐ May be ☐ Not sure

If yes, what is that?

24. Do you currently use Vegan protein powder?

☐ Use it on a regular basis

☐ Use it only sometimes

☐ Have never used it

25. Can you list from which vegan protein can be prepared?

26. Have you tried making vegan protein powder in home?

☐ Yes ☐ No

27. In what foods vegan protein powder can be incorporated?

28. If you use protein powder, what do you primarily use protein powder for

☐ Mix with water / drinks ☐ Baking

☐ Mix with Dosa batter, chutneys, etc ☐ Others

29. Do you know the benefits of Vegan/plant based protein powder?

☐ Yes ☐ No

☐ May be ☐ Not sure

If yes, What are they?

30. If you have never used protein powder, Why not?

31. Which of the following factors matter to you while choosing protein supplements?

☐ Taste ☐ Price

☐ Quality ☐ Quantity

☐ Others If it is others, what is that?

32. What do you care about the most when it comes to vegan protein powder?

☐ Gluten free ☐ No additives ☐ Low carb

33. Do you think vegan protein powder for long time will create any advance effects or ill effects?

☐ Yes ☐ No

☐ Maybe ☐ Not sure

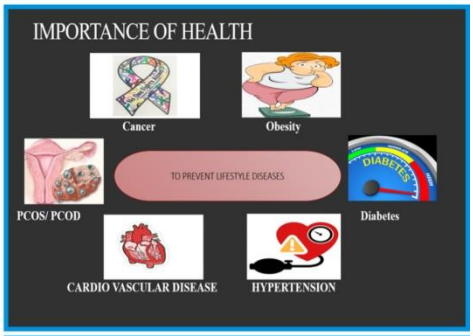
34. will you suggest vegan protein powder for your friends, relatives and neighbors?

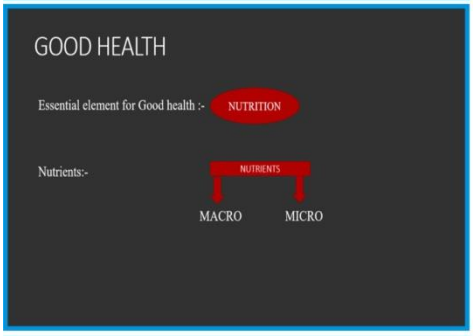
☐ Yes ☐ No

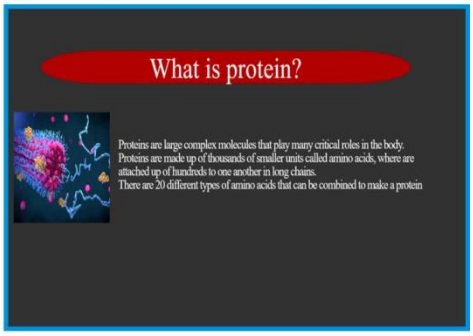
☐ Maybe ☐ Not sure

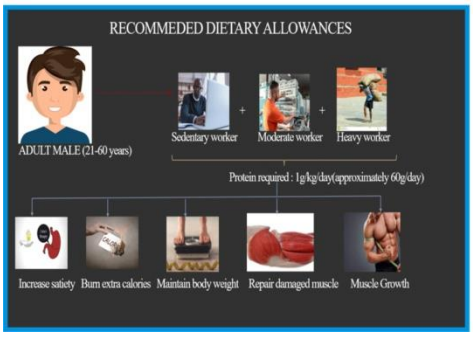
ANNEXURE - IV

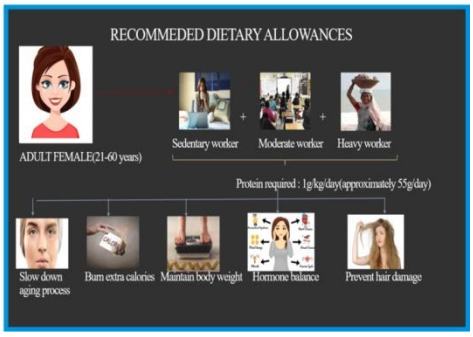
Education Material used to Create Awareness on Vegan Protein Powder











RECOMMEDED DIETARY ALLOWANCES

PREGNANT WOMEN

Protein required : 78g/day

Helps baby's tissue and organ growth

Breast and Uterine tissue growth

Allowing more blood circulation to the baby

Antibodies for immune system

Healthy Birthweight

RECOMMEDED DIETARY ALLOWANCES

LACTATING WOMEN

0-6 months
Protein required : 74g/day

6-12 months
Protein required : 68g/day

To produce breast milk

Sustain baby growth

Grow new cells in organs

Aids lose weight

Maintain muscle mass

RECOMMEDED DIETARY ALLOWANCES

+

PRE-SCHOOL CHILDREN(Boys and girls)

1-3 years – Protein required : 16.7g/day

4-6 years – protein required : 20.1g/day

7-9 years- protein required :29.5g/day

Increased muscle mass

Improves Immunity

High Growth Rate

Increase Concentration

Rapid Wound Healing

RECOMMEDED DIETARY ALLOWANCES

10-12 years- Protein required :39.9g/day

SCHOOL GOING CHILDREN BOYS

10-12 years – Protein required : 40.4g/day

SCHOOL GOING CHILDREN GIRLS

Importance of protein in school going children(10 -12 years)

Healthy Bone development

Maintain weight Weight

Proper Growth

Improves Immunity

Promote healthy Metabolism

RECOMMENDED DIETARY ALLOWANCES

13-15 years – Protein required : 54.3g/day

16-17 years – Protein required : 61.5 g/day

Adolescents (Boys)

13-15 years – Protein required: 51.9g/day

16-17 years – Protein required: 55.5g/day

Adolescents (Girls)

Importance of protein in Adolescents(13- 17 years)

Healthy Muscle

Maintain Weight

Proper growth of brain

Hormone Regulation

Promote healthy Metabolism

Protein Contribution from day's diet(adult man)

Time	Food
Early Morning	Green tea
Breakfast	Idly Tomato chutney
Mid Morning	Paruppu Vada
Lunch	Rice Red lentil dhal curry Boiled Channa
Evening Snacks	Bread with peanut butter
Dinner	Upma Coconut chutney Oats milk Kheer

Protein contribution from day's diet (adult man)

Total protein content in day's menu = 33.98g pro
Recommended intake by ICMR = 60g/day

Idly (100g) - 3.79g pro

Bread with peanut butter(100g)-10.82g pro

Paruppu vada (70g) – 5.39gpro

Oats Milk kheer (100 ml) –5.74g pro

Boiled Channa(100g)- 3.46 g pro

Red lentil dal curry (100g)- 4.78g pro

Protein Contribution from day's diet (adult woman)

Time	Food
Early Morning	Green tea
Breakfast	Pongal Coconut chutney Urad dal Vada
Mid Morning	Tofu aloo sandwich
Lunch	Rice Brinjal Puli kulambu Boiled green gram
Evening Snacks	Almond soymilk shake
Dinner	Chapati Channa curry

Protein Contribution from day's diet (adult woman)

Pongal (100g) – 3.65g Pro

Boiled green gram(100g) – 4.96g Pro

Total protein content in day's menu = 30.71g pro
Recommended intake by ICMR = 55g/day

Urad dal Vada (60g) – 6.31g Pro

Almond & Soymilk shake(100ml) –6.82g pro

n)

100g) - 4.46g Pro

Tofu Aloo Sandwich(100g) –4.51g Pro

Protein content of Animal sources (100gm)

Food items	Protein Content
Fish (varieties)	20-60g
Chicken	36g
Beef	36g
Meat	22g
Egg	13g
Curd	6g
Milk(cow)	3g

Protein content of pulses and legumes(100gm)

Food items	Protein content
soyabean	36g
Black gram	24g
Green gram dhal	24g
peas	23g
Bengal gram dhal	22g
Red gram dhal	22g
chana	19g
Beans	18g

Protein content of Nuts and seeds (100gm)

Food items	Protein content
Pumpkin seeds	30g
Fenugreek seeds	25g
Peanut	23g
Almond	21g
Cashew nut	21g
Pistachios	20g
Flax seed	18g
Walnut	15g

Vegan VS Vegetarian

VEGAN

Vegan diet doesn't include meat and animal products.

(Meat, Poultry, fish, Egg, honey ,dairy products and any other products that are derived from animals)

VEGETARIAN

Vegetarian diet doesn't include meat, fish, poultry, egg and any other products that are derived from animals but they can include dairy products.

Is vegan food nutritious ?

Vegan food, like any other food, can be healthful or unhealthy.

- ✓ Fruits
- ✓ Vegetables
- ✓ Legumes
- ✓ Beans
- ✓ Lentils
- ✓ Salads
- ✓ Tofu
- ✓ Natural Nut milk
- ✓ Sprouts
- ✓ Brown rice
- ✓ Red rice
- ✓ Cold pressed oil

- ✗ Refined sugar
- ✗ Processed flours
- ✗ Fried foods
- ✗ Excessive cooking oils

Where can you find Vegan alternatives ?

Plant-based alternatives are becoming increasingly frequent as veganism becomes more fashionable.

Available in Shops, Online stores (Vegan Dukan, where you may purchase everything you need for a vegan lifestyle, from plant-based dairy to faux meat)

Is Vegan food more expensive than Non veg foods ?

No! Vegan foods are really cost effective, Whole grains, cereals, pulses, vegetables are not expensive than meat and dairy products.

Is it true that being vegan has an effect on hormones?

According to Palmer, there is some evidence that vegan diets are associated with lower levels of particular sex hormones than meat-heavy diets.

"However, studies haven't demonstrated any deleterious impacts of these lower doses of hormones," Palmer says.

Is it true that vegan diet helps to lose weight?

A plant-based diet is linked to a healthy weight, weight loss, and a reduced BMI, according to research. This, according to some scientists, is due to the high fiber content and low saturated fat content. Whole-food, plant-based diets are prone to this.

Is it true in order to absorb protein, vegetarian must contain particular foods?

Combining vegetarian proteins to create a "complete protein" or "complementary protein" is an outdated concept.

We now know that our bodies store amino acids which can be used to compensate for any limiting amino acid in a vegetarian diet.

Is it possible everyone to be vegan?

Vegan diets that are well-planned are suitable for people at all phases of life, including pregnancy, nursing, infancy, youth, and adolescence, as well as athletes.

Is it possible to eat vegan diet that is both healthy and nutritionally complete?

It depends on what you eat. No diet, neither meat-based or plant-based is healthy and nutritionally complete. It can be, provided that you eat in a healthy, complete and nutritionally balanced way!

Is it ok to eat some of the vegan meat alternatives that are already prepared ?

Vegan meat substitutes can be a good source of protein, and they're typically supplemented with other nutrients.

Is it possible everyone to be vegan?

Vegan diets that are well-planned are suitable for people at all phases of life, including pregnancy, nursing, infancy, youth, and adolescence, as well as athletes.

Is it possible to prepare vegan friendly alternatives at home?

Yes , Vegan foods can be prepared at home if the appropriate goods to use in place of non-vegan ones.

Examples:

1. Animal milk replaced with Plant milks such as Soy, Almond, Coconut, Rice
2. Faux meat
3. panner replaced with Tofu

People claims that because vegetarian don't consume meat they don't receive enough protein in theirs diet, is this correct ?

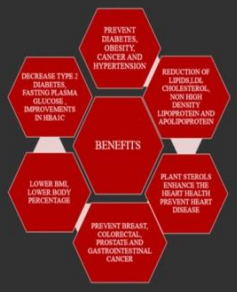
No. Vegetarian diets, and even vegan diets which are a bit more restrictive, can contain more than enough plant protein for your body to thrive and for you to maintain a healthy, active lifestyle, as long as your diet is planned properly.

Ingredients used in Vegan protein powder

Why Vegan?

- Boost immune system
- Reduce inflammation
- Maintain a healthy weight
- Increase fiber
- Lower cancer risk
- Reduce Cholesterol level

BENEFITS OF VEGAN PROTEIN POWDER



Incorporation of vegan protein powder

Preschool children (1 -9 years) = Snacks

Balls (2 no's)	Muffins(2 no's)	Halwa(30g)	Porridge(60g)	Murukku(40g)
2 tbsp protein powder	2 tbsp protein powder	2 tbsp protein powder	2 tbsp protein powder	3 tbsp protein powder

Incorporation of vegan protein powder

School Going children (10 -13 years) = Snacks

Balls (3 no's)	Muffins(2 no's)	Halwa(40g)	Porridge(60g)	Murukku(40g)
2 tbsp protein powder	2 tbsp protein powder	2 tbsp protein powder	2 tbsp protein powder	2 tbsp protein powder

Milks

Almond milk (200ml)	Coconut milk(200ml)	Cashew milk(200ml)	Oats milk (200ml)
2 tbsp protein powder	2 tbsp protein powder	2 tbsp protein powder	2 tbsp protein powder

Incorporation of vegan protein powder

Adolescents(13- 17years) = Snacks

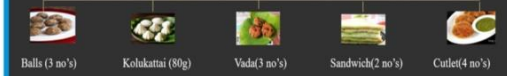
Balls(3 no's)	Muffins(2 no's)	Vada(3 no's)	Sandwich(80g)	Murukku (3 no's)
2 tbsp protein powder	2 tbsp protein powder	3 tbsp protein powder	2 tbsp protein powder	3 tbsp protein powder

Meals

Aloo paratha(2no's)	Puttu (150g)	Tomato Dosa(3 no's)	Curries(80g)	Idly (3 no's)
3 tbsp protein powder	2 tbsp protein powder	3 tbsp protein powder	2 tbsp protein powder	3 tbsp protein powder

Incorporation of vegan protein powder

Adults(18- 60years) = Snacks

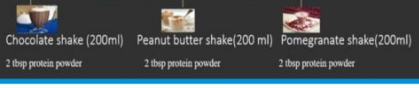


Balls (3 no's)	Kolukattai (80g)	Vada(3 no's)	Sandwich(2 no's)	Cutlet(4 no's)
3 tbsp protein powder	3 tbsp protein powder	3 tbsp protein powder	2 tbsp protein powder	3 tbsp protein powder

Meals

Chapati(3 no's)	Stuffed Naan(3no's)	Kichadi(200g)	Curries(80g)	Idly(3no's)
3 tbsp protein powder	3 tbsp protein powder	3 tbsp protein powder	2 tbsp protein powder	3 tbsp protein powder

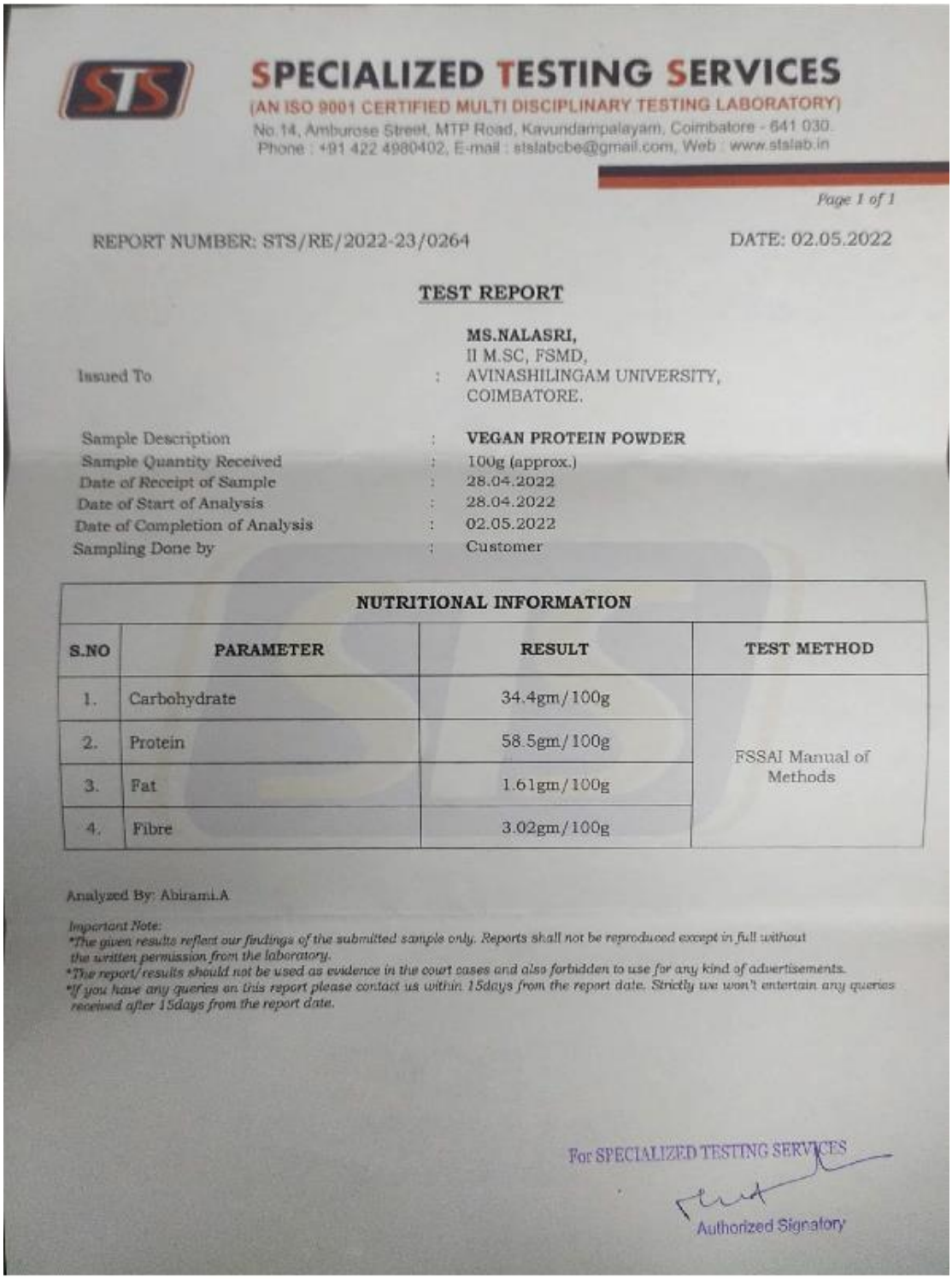
Shakes



Chocolate shake (200ml)	Peanut butter shake(200 ml)	Pomegranate shake(200ml)
2 tbsp protein powder	2 tbsp protein powder	2 tbsp protein powder

ANNEXURE –V

NUTRITENT AND SHELFLIFE ANALYSIS OF ISOLATED VEGAN PROTEIN POWDER



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Phone : +91 422 4980402, E-mail : stslabcbe@gmail.com, Web : www.stslab.in

Page 1 of 1

REPORT NUMBER: STS/RE/2022-23/0264 DATE: 02.05.2022

TEST REPORT

Issued To	:	**MS.NALASRI,** II M.SC, FSMD, AVINASHILINGAM UNIVERSITY, COIMBATORE.
Sample Description	:	**VEGAN PROTEIN POWDER**
Sample Quantity Received	:	100g (approx.)
Date of Receipt of Sample	:	28.04.2022
Date of Start of Analysis	:	28.04.2022
Date of Completion of Analysis	:	02.05.2022
Sampling Done by	:	Customer

NUTRITIONAL INFORMATION

S.NO	PARAMETER	RESULT	TEST METHOD
1.	Carbohydrate	34.4gm/100g	FSSAI Manual of Methods
2.	Protein	58.5gm/100g	
3.	Fat	1.61gm/100g	
4.	Fibre	3.02gm/100g	

Analyzed By: Abirami.A

Important Note:
**The given results reflent our findings of the submitted sample only. Reports shall not be reproduced except in full without the written permission from the laboratory.*
**The report/results should not be used as evidence in the court cases and also forbidden to use for any kind of advertisements.*
**If you have any queries on this report please contact us within 15days from the report date. Strictly we won't entertain any queries received after 15days from the report date.*

For SPECIALIZED TESTING SERVICES

Authorized Signatory

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REPORT NUMBER: STS/RE/2022-23/0264

DATE: 02.05.2022

TEST REPORT

Issued To : **MS.NALASRI,**
II M.SC, FSMD,
AVINASHILINGAM UNIVERSITY,
COIMBATORE.

Sample Description : **VEGAN PROTEIN POWDER**
Sample Quantity Received : 100g (approx.)
Date of Receipt of Sample : 28.04.2022
Date of Start of Analysis : 28.04.2022
Date of Completion of Analysis : 02.05.2022
Sampling Done by : Customer

MICROBIOLOGICAL ANALYSIS – 1ST DAY

S.NO	PARAMETER	RESULT	TEST METHOD
1.	TPC	$3x10^1$CFU/g	BIS
2.	E.Coli	Absent	
3.	Salmonella	Absent	

Analyzed By: Kaviya.C

Important Note:
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REPORT NUMBER: STS/RE/2022-23/0266

DATE: 07.05.2022

TEST REPORT

Issued To	:	**MS.NALASRI,** II M.SC, FSMD, AVINASHILINGAM UNIVERSITY, COIMBATORE.
Sample Description	:	**VEGAN PROTEIN POWDER**
Sample Quantity Received	:	100g (approx.)
Date of Receipt of Sample	:	28.04.2022
Date of Start of Analysis	:	04.05.2022
Date of Completion of Analysis	:	07.05.2022
Sampling Done by	:	Customer

MICROBIOLOGICAL ANALYSIS – 7TH DAY

S.NO	PARAMETER	RESULT	TEST METHOD
1.	TPC	$18x10^1$CFU/g	BIS
2.	E.Coli	Absent	
3.	Salmonella	Absent	

Analyzed By: Kaviya.C

Important Note:
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For SPECIALIZED TESTING SERVICES

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