

**EVALUATION OF ACCEPTABILITY AND NUTRITIVE VALUE OF
RECIPES INCORPORATED WITH LOTUS ROOT POWDER**

By

SANDHIYA.S

(20PFD026)

Thesis submitted to

Avinashilingam Institute for Home Science and Higher Education for Women

Coimbatore – 641 043

In Partial Fulfillment of the Requirement for the

Degree of Master of Science in

FOOD SERVICE MANAGEMENT AND DIETETICS

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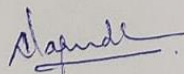
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Degree in Master of Science in

Food Service Management and Dietetics

MAY, 2022

Certified as a Bonafide Research Work



**Signature of the Head
of the Department**



Signature of the Supervisor

ACKNOWLEDGEMENT

ACKNOWLEDGEMENT

The investigator exalts **God Almighty** for being her refuge and strength and praises him for his everlasting love, bountiful mercy and amazing grace showered on her thought the study.

The investigator pays her reverential homage to **(Late) Dr. T. S. Avinashilingam**, Founder, and First Chancellor, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, for being a perennial source of inspiration. Reverential homage is paid to the Doyen of Nutrition Colonel and **Dr. Rajammal P. Devadas**, Former Chancellor, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, for being a perennial source of inspiration.

The investigator expresses her gratitude to **Sri. T. S. K. Meenakshi Sundaram**, **(Honoris Caussa)**, Managing Trustee, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, for providing an opportunity to conduct the study. The investigator is grateful to **Dr. S. P. Thygarajan**, Chancellor, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, for providing an opportunity, infrastructure and all amenities to conduct the study.

The investigator owes her special thanks and gratitude to **Dr. V. Bharathi Harishankar**, Vice Chancellor, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, for facilitating the completion of the study. She records her gratitude to **Dr. S. Kowsalya**, Registrar, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, for providing all the facilities for the smooth conduct of the study.

She expresses her heartfelt thanks to **Dr. N. Vasugi**, Dean Faculty of Home Science, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, for her help and constant support to carry out the research.

The investigator expresses her special thanks and sincere gratitude to **Dr. S. Uma Mageshwari**, Dean Student Affairs, Professor and former Head of the Department of Food Service management and Dietetics, Avinashilingam Institute for Home Science and Higher Education For Women, Coimbatore, for her keen interest, valuable help, concern and encouragement which has helped in the successful completion of the study. The investigator expresses her special thanks and sincere gratitude to **Dr. V. Premala Priyadharshini**, Head

of the Department of Food Service management and Dietetics, Avinashilingam Institute for Home Science and Higher Education For Women, Coimbatore, for her keen interest, valuable help, concern and encouragement which has helped in the successful completion of the study.

The investigator expresses her deep sense of gratitude and whole hearted thanks to her supervisor **Dr. S. Karthiga**, Assistant Professor, Department of Food Service Management and Dietetics, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, whose ability to probe beneath text was a true gift and her insight have strengthened this study significantly. Her meticulous guidance, deep concern, constructive suggestions, continued motivation, enduring support and gentle care rendered from the initial to the final level of the study enabled the investigator to complete the research successfully.

The investigator acknowledges with gratitude the good wishes and encouragement of **all the staff members of the Department of Food Service Management and Dietetics**, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore.

The investigator expresses her heartfelt thanks to **loving parents, sisters, brother and other family members and friends whose motivation**, care, concern and support cannot be expressed in words.

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INTRODUCTION

I. INTRODUCTION

Health is key for sustenance of life. Everywhere around us we have come across the slogan “Eat Healthy Stay Healthy”. The World Bank estimates that India's population will reach 1.38 billion in 2020. As the second-most populous nation and one of the world's fastest-growing economies, India presents both difficulties and opportunity for public health (World Bank, 2021).

India faces significant public health challenges, including child malnutrition, high rates of neonatal and maternal mortality, an increase in non-communicable diseases, a high rate of road traffic accidents, and other health-related issues, despite being a global center for pharmaceutical and biotechnology companies, as well as world-class scientists, clinical trials, and hospitals.

India has in its quiver, a myriad of plants that possess nutritional & medicinal properties but remains untapped. These neglected plants have high nutritional value and can feed the world's growing population. Many of them are resilient, adaptable, and tolerant to a variety of climatic situations. Despite the fact that they may be raised at a reduced management cost, they have remained underutilized due to a lack of understanding and popularization of technology for use.

In this respect, one such identified potential underutilized plant food is lotus seed, which has been studied for decades but remains unexplored. Lotus seed (*Nelumbonuciferae* Gaertn) is an aquatic perennial crop farmed and consumed throughout Asia. *Nelumbonucifera*, one of the world's oldest plants, can be found from Egypt to Iran, India, China, Japan, and Australia in tropical and subtropical Middle East Asia. It is widely farmed in Southeast Asia (mostly in China), primarily for food and in much smaller amounts for herbal medicine. Although the major goal of cultivation is to collect rhizomes and seeds, all parts of the plant are utilised (Lavor et.al. 2018).

The Local/ Vernacular names of Lotus were Kanwal, Kamal and Purain (Hindi); Pamposh (Kashmiri & Punjabi); Podam (Assamese); Padma (Bengali, Oriya & Sanskrit); Tavaregida, Kamal (Kannad); Sohlapudong (Khasi); Tamara, Chentamara (Malyalam); Kamal (Marathi); Tamarai (Tamil); Kalung, Erra-tamara (Telgu). *Nelumbonucifera* is the botanical name of the lotus Family: *Nelumbonaceae*. *Nelumbo* is the only genus in this family.

Its root has node of a validated rhizome produces approximately 20 to 25 fibrous roots. When young, fibrous roots are creamy white and contain few root hairs. These roots, which are approximately 15 cm in length, become dark brown as they age.

The lotus rhizome is often creamy white in color and fashioned like a wooden sausage; however, it can also be seen with a light brown colour. The terminal root of the lotus root system produces the rhizome. One rhizome often produces three to four "sausages" measuring 60 to 90 centimeters in length, with the smallest measuring 4-6 centimeters in diameter and 10-15 centimeters in length, and the largest measuring 5-10 centimeters in width and 10-12 centimeters in length.

The lotus leaf is enormous, round, and has a diameter of 20-100 cm. It is green, greyish green, or reddish-green in colour, and has a thick wax covering on the surface. There is a leaf- navel in the centre of the leaf, from which veins radiate out to the edge. The earliest leaves that emerge from the seed are reddish green in colour, tiny, with a rolled edge, and a weak, flimsy, and easily broken stalk. These earliest leaves are known as "under-water-leaves" because they open in the water. The next leaves, known as "floating leaves," are slightly larger in size but still have the delicate leaf stalk and can only float on the water. The width and height of lotus leaf stalks, which have a spiky texture, vary based on the plant's age, from small and soft in the early stages to larger and stronger in the latter stages. Lotus leaves contain a vast number of fragrance compounds, with cis-3-hexenol accounting for 40% of them.

Typically the flowers of *N. nucifera* are pink or white in various shades distributed in various geographical regions of India ranging from Kashmir to Kanyakumari. This species has acquired the wealth of fascinating stories and symbolism, which are associated with Hindu, Buddhist and Jain religions and also found place in Ramayana, Mahabharata and the holy Bible. Lotus buds appear in the spring, and the bud unfolds to become a lotus flower two weeks later.

The fruit of the lotus root tend to stay open for the longer duration each day, until the petals are shed for revealing the most attractive funnel – shaped torus having seeds looking like the rose of a watering can. The top of the torus is between 5 and 12 centimeters in diameter, initially downy and greenish yellow, and then green, finally drying to a brown woody texture and becoming very hard, dry, and darker with age (Shen-Miller et al., 1995). This water- and airtight construction is the single most critical factor in determining the longevity of Lotus seeds. There is an abundance of chlorophyll in the two embryonic plumules of lotus seeds.

Once germination commences, mature seeds' photosynthetically active green tissues provide a pathway for immediate photosynthesis and growth.

Lotus root is high in nutrients and has numerous health benefits. Eating lotus root has a number of health benefits, including lowering cholesterol, improving digestion, lowering blood pressure, and boosting immunity (Freigang 2016 and Lu 2019). Lotus root also aids in the prevention of cancer, mood regulation, depression relief, blood pressure elevation, and the maintenance of correct enzyme function in the body.

Plants are commonly employed as antioxidants and free radical scavengers to slow the oxidation process. In Traditional Chinese Medicine, lotus root was regarded as a potent astringent herb that treats all types of bleeding and hematemesis. According to reports, lotus root offers hypoglycemic, antifungal, anti-inflammatory, antipyretic, and antianxiety effects (Ling 1984 and Mukherjee 2009)

Lotus root can be consumed in a variety of ways, including powder or chips, and it is used as a tea flavoring.

Lotus root regulates blood circulation, helps to regulate blood pressure, aids digestion, Strengthens body immunity power, strengthens mental and physical health and treats fungal infection.

Lotus root has been utilized for thousands of years for its medicinal properties. This vegetable has 700-year-old archaeological remnants in China. Lotus is largely grown in Asian countries such as China, Japan, India, Indonesia, and the Philippines, although it is also grown throughout the world. The Lotus plant is a lovely plant with roots that sink to the bottom of a lake, stream, or river, while the pad and flower remain above water. Because it is an aquatic perennial plant, seeds can germinate long after the plant has gone dormant. Seeds should be sown in a glass of warm, non-chlorinated water. Set the lotus plant in warm water until the water temperature reaches 60 degrees Fahrenheit. (Du et.al. 2010)

The sweet and plain nature of lotus root powder is thought to activate blood, stop bleeding, control middle qi, whet hunger, and heal deficiencies and haemorrhages, according to traditional Chinese medicine. After childbirth or hematemesis, it is critical to consume this diet. According to the Chinese Medical Dictionary, lotus root powder alleviates summer heat, promotes saliva or body fluid secretion, aids digestion, regulates middle qi, satisfies hunger, clears outer heat, keeps yin and wei qi in balance, clears extravasated blood, and generates new

blood. The Compendium of Materia Medica states that consuming lotus root powder is healthful (Kaneyasu, 2019)

Many modern studies have confirmed traditional knowledge about the medicinal properties of the lotus plant. Antifungal, antipyretic, emollient, sudorific, diuretic, and cardiotoxic properties are all found in the whole plant. Various parts of the lotus plant are commonly used to treat tissue inflammation, diarrhoea, and haemostasis (Yu et.al. 1997).

Pectoralgia, leucoderma, pharyngopathy, dysentery, spermatorrhoea, cough, small pox, and diarrhoea are all traditional uses for the rhizomes. The stem is used in Ayurveda to treat nervous weariness, strangury, leprosy, skin disease, and vomiting as a diuretic and anthelmintic.

Rectal prolapse is treated using a mixture of young leaves and sugar. Antidiarrheal leaves boiled with goat's milk and *Mimosa pudica* are employed. Fever and inflamed skin can be treated with natural treatments made from leaf paste. Metrorrhagia, hematemesis, hemoptysis, hematuria, and epistaxis can all be treated with the leaves (Ou 1989). The treatment of hyperlipidemia in rodents with lotus leaves was described in an experiment (Cour 1995 and Onishi 1984).

Leaves with astringent characteristics are used to cure strangury, fever, and perspiration, as well as as a styptic (Chinese Materia 1997).

The flowers and leaves are useful in the treatment of bleeding problems. Flowers can help with conception and are also useful in the treatment of fever, diarrhoea, hyperdipsia, cholera, and hepatopathy.

Traditional folk medicine uses seeds as a refrigerant and diuretic for the treatment of poison antidote and skin condition, and seeds are widely prescribed as a refrigerant and diuretic to children. The seeds and fruits are astringent and can be used to treat a range of skin disorders, including hyperdipsia, halitosis, and menorrhagia. A mixture of honey and seed powder can be used to cure coughing. Ghee and roots, as well as milk and gold, promote virility and strength.

As an antibiotic, lotus seeds have been utilized due to their antibacterial properties. LianZi Xin, a Chinese medication derived from lotus seed embryos, is used to treat insomnia, various cardiovascular issues (e.g., hypertension and arrhythmia), mental disorders, and high fevers (along by agitation) (Bae et.al. 2015)

In today's developing world of food scarcity, nutritional insecurity and hidden hunger, there is an urgent need to exploit the neglected and lesser known plants with food potential like lotus root flour. In view of long standing and widespread prevalence of malnutrition, it can become a good food supplement among people of our country and provide them relief from various disorders.

Therapeutic use of lotus root powder can be broadened for the health benefits because of its well recognised medicinal properties and highly nutritional significance. Commercial production of lotus root powder will bring waste land and degraded land under cultivation. In whole India, it is popular as traditional vegetable and used in preparing a wide variety of dishes. Lotus root can be successfully incorporated in developing various products suitable for vulnerable section of rural and urban population not only to meet nutritional requirement especially that of protein, iron, calcium etc. but also secretly cure many ailments or check their incidence.

Evaluation on lotus root consumption is scanty and studies are needed on the impact that lotus root as food stuff on humans is needed. Lotus root has unique appearance, color, flavor and texture. When it is cooked its uniqueness act as a supplement of iron and vitamins. The analysis of the prepared product will have great impact on increasing health benefits for human and it will also be supplement in the main course food consumption.

Therefore an attempt has been made towards “Evaluation of Acceptability and Nutritive Value of Recipes Incorporated with Lotus Root Powder” with the following objectives:

1. To elicit data on the use of lotus root among the general population.
2. To evaluate the nutrient content of fresh and dry lotus root.
3. To develop food products with fresh and dry lotus root.
4. To create awareness on incorporation of lotus root in commonly prepared recipes.

REVIEW OF LITERATURE

II. REVIEW OF LITERATURE

The literature reviewed for the current study of “Evaluation of Acceptability and Nutritive Value of Recipes Incorporated with Lotus Root Powder” is presented under the following heads:

- A. Prevalence of calcium and iron deficiency
- B. Value addition of recipes and their sensory evaluation
- C. Functional and traditional foods rich in calcium and iron
- D. Nutritional significance of lotus root and its incorporation in recipes

A. Prevalence of calcium and iron deficiency

Calcium and vitamin D are two minerals that are essential for bone health. Dietary calcium intake in rural, tribal, and urban India has decreased during the last half-century. Rural and tribal subjects consumed the most cereals and the least milk and milk products, whereas urban and metropolitan subjects consumed the same amount of cereals, milk, and milk products. (Harinarayan et.al. 2021)

Based on the report of World Health Organization (2021), the average 30-day cereal consumption in rural and urban populations has decreased by 30% in the last half-century. Despite persistent increases in Monthly Per capita Consumption Expenditure (MPCE) in both rural and urban households, Per Capita Cereal Consumption (PCCC) has decreased. Because cereals were distributed through the Public Distribution System (PDS), the lowest income group had the highest cereal consumption, although spending a lesser fraction of their income.

Tania et.al. (2016) reported that calcium deficiency was found in 25.6 percent of children aged 1–4 years and 54.5–88.1 percent of those aged >5 years. Iron deficiency was found in more than 45 percent of participants over the age of five. Magnesium deficiency was found in less than 5% of children under the age of 12 and 25–35 percent of participants over the age of 12, while zinc deficiency was found in 10% of children under the age of 12.

In modern India, the consumption of dietary calcium, milk, milk products, and grains has decreased dramatically over the last half-century, despite the upward adjustment of the Recommended Dietary Allowances (RDA)/ Recommended Dietary Intake (RDI). There is a strong rural–urban split in milk, milk products, and cereal intake, as well as a shift in dietary habits that exacerbates calcium and vitamin D inadequacy. (Harinarayana et.al 2019)

The effects of these dietary factors on iron absorption, however, do not always imply a link between iron status and iron storage (serum ferritin concentration). Only meat consumption has consistently (positively) been linked to greater blood ferritin concentrations in cross-sectional studies. The beneficial effects of ascorbic acid and meat on iron absorption may be counteracted by the consumption of inhibitory foods and minerals at the same time. The combination and timing of foods ingested have been studied in recent cross-sectional research, with varied results. (Beck et.al. 2014).

There is strong evidence that supplemental iron given in physiological amounts can increase the risk of bacterial and protozoal infections (especially malaria), but in most cases, using lower amounts of iron provided within a food matrix, i.e. fortified food, should be safer and represents a more logical strategy for a sustained reduction of the risk of deficiency by providing the best risk-benefit balance. (Prentice et.al.2017)

Gera et.al. (2012) have reported that iron fortification of foods resulted in a significant increase in hemoglobin and serum ferritin, a reduced risk of anemia and iron deficiency. The majority of the studied outcomes showed significant heterogeneity. Sensitivity analyses and meta-regression for hemoglobin suggested a higher response with lower trial quality use of condiments, and sodium iron edentate, and a lower response with a higher response with a lower trial quality, use of condiments, and sodium iron edentate, and a lower response with a lower trial quality.

Anemia is currently caused by insufficient iron intake and/or bioavailability, which is one of the most common nutritional problems worldwide. The scientific challenge in combating this public health issue is to find an iron form with sufficient bioavailability so that it may be increased in humans through dietary fortification. The management of these compounds can thus successfully improve the absorption of dietary iron and, ultimately, contribute to fight this disorder present all over the world (Liberal et.al. 2020)

For the age groups of 5–11 years and 12–15 years, anemia was defined as a haemoglobin level less than 11.5 g/dl and 12 g/dl, respectively. Serum iron and ferritin levels below 10 mol/l and 15 g/dl, respectively, were used to identify iron deficiency anemia. The prevalence of anaemia was 43.7%, and that of IDA was 37.4%. (Wolide et.al. 2018)

Anemia affects 74 percent of children under the age of three, 85 percent of expecting moms, and over 90 percent of adolescent teenagers in India. Indian Dietetic Association (IDA)

impairs cognitive performance, labor capacity, and productivity, and raises the risk of maternal morbidity and mortality as a result of prolonged malnutrition, lack of dietary iron bioavailability, or physiological variables. (WHO 2021).

B. Value addition of recipes and their sensory evaluation

Zaidi et al. (2021) discovered that substituting Lotus stem powder (LSP) for refined flour in the making of cookies reduced the amount of LSP in the final product, with the greatest reduction of LSP in the final product. When the LSP is increased, the size of the cookies shrinks after baking, increasing the crispiness of the cookies. The formulation with the highest level of replacement, R1, was evaluated the sensory evaluation of the product using the Nine Point Hedonic Scale of flavor for the product, while formulation R2, with 50% of replacement by lotus stem powder, presented close resemblance.

Chaudry and Pareek (2010) studied to create a value-added soy blended product, such as Khakare, by using lotus stem powder and defatted soy flour at various levels. The sensory evaluation found that the combination of 20% defatted soy flour and 5% lotus stem powder was the most agreeable and obtained the highest ratings among the various proportions of components utilized.

According to Vora and Srinivasan (2016) gender, age, income, education, shopping habits, and type of food purchased are all factors that influence consumer choice and inclination to promote lotus stir-fry, according to the findings. Consumer approval of fresh lotus rhizomes and value-added goods is determined by the findings.

Lotus has been thoroughly evaluated for anticancer, anti-obesity, antioxidant, anti-inflammatory, and antiviral action, as well as to combat neurological illnesses and improve cardiovascular activity. Although lotus is native to many parts of Alabama and the United States, commercial cultivation of the plant raises concerns about its long-term viability as a specialty vegetable crop in Alabama and the United States. (Xiong et.al. 2013)

Park et al., (2010) evaluated quality attributes of dried noodles when different amounts of lotus leaf powder (LLP) were added to wheat flour. The maximum viscosity values of those samples fell as the LLP concentration increased, as determined by an amylograph. In addition, as the amount of LLP was raised, the L and a values decreased, while the b value grew. The color values, weight and volume of the cooked noodle increased, as did the turbidity of the

soup. LLP additive increased hardness and cohesiveness, and reduced adhesiveness and springiness.

Kim et al., (2008) examined the quality aspects of cookies made with lotus leaf powder instead of flour. At all quantities of lotus leaf powder, the pH of the cookie dough dropped dramatically. An inverse association between the lotus leaf powder concentration and the control. Hunter's color L, a, and b values also fell dramatically with increasing lotus leaf powder content. The substitution of for flour resulted in enhanced hardness, cohesion, springiness, and brittleness, according to textural measurements.

Yoon et al. (2009) found that the lotus leaf powder had a moisture content of 6.00 percent, a crude protein content of 19.56 percent, a crude fat content of 0.78 percent, a carbohydrate content of 64.7 percent, and a crude ash content of 8.93 percent The 6 percent lotus leaf Dasik made with 188 g flour, 12 g lotus leaf powder, and 200 g honey had the greatest preference values in the sensory assessments and was thus picked as the best product.

Bodyfelt et al. (2005) say that scoring is a more often utilized form of food sensory testing. Only 79 calories are in a cup of boiled lotus stem. When the stem is particularly fresh, it can have a touch of milky mucilage and is quite fibrous and crunchy. Lotus stem is thought to be a good meal for maintaining facial skin suppleness.

Lotus leaves are known for refrigerate astringent and diuretic properties, according to Ku-lee et al (2005). This led to a variety of uses, including treating diarrhoea, high fever, haemorrhoids, and leprosy with lotus leaves. Traditional liquor (lotus loquore) is made in Korea from lotus bosoms and leaves, which have been proven to contain antioxidant properties that can help reduce oxidative stress and the risk of chronic disease.

The texture of lotus root is hard and crispy, according to Chiang and Luo (2007), and the root can maintain its appearance and mouth feel after cooking at 100 °C for more than 60 minutes. The amount of Non digestible fraction (NDF) in the body reduced more than the amount of Alternative Day Fasting in the body. With increasing pressurized cooking temperature/duration, relative hardness of lotus root reduced while solid loss increased (P 0.05).

According to Sridhar et al. (2007), lotus seeds (*Nelumbonucifera*) are edible, medicinally versatile, and a key raw material in age-old traditional medical practices such as Ayurveda and folk medicine. Seeds are used in Ayurveda and folk medicine to treat a wide

range of maladies, including tissue inflammation, cancer, diuretics, skin problems, and poison antidotes. Alkaloids, flavonoids, antioxidants, ant steroids, antipyretic, anticancerous, antiviral, and anti-obesity effects are all found in Lotus plants.

Park et al. (2009) discovered that all lotus cultivars have high levels of bioactive compounds, including total phenols equivalents, ascorbic acid and amino acids. The highest levels of antioxidant and anti-proliferative activities on both human cancer cell lines Calu-6 for human pulmonary carcinoma and SMU-601 for human gastric carcinoma.

Hidemi et al. (2010) assessed the microbiological and physiological quality of fresh cut lotus after high pressure treatment in water-filled film packaging stored at 1, 5, and 10 degrees Celsius. The first cut lotus root developed less brown discoloration at 5°C than at 10°C, and the fresh cuts did not develop browning after storage at 1°C. At all temperatures, the high pressure treatment reduced phenyl alanine ammonia lysae (PAL) activity and respiration rate while having no effect on the texture of fresh cut lotus root.

Lui and Lee (2010) investigated the processing properties and flavor of lotus root powder beverages. Lotus root powder is a well-known aquatic vegetable in China that is high in protein, amino acids, dietary fiber, starch, and vitamins C, B1, and B2. Salads, pickled dishes, stir-fried foods, and confections are all made with it. During the powdering process, certain heat labile chemicals were evidently lost. However, due to their processing qualities, minimal starch and soluble dietary fibre was lost.

Shad et al. (2010) discovered that the lotus rhizome is a poor source of crude oil. Acid value, saponification value, and unsaponifiable matter were evaluated as physico-chemical parameters of the oil. The temperature-dependent behavior of flour solubility and swelling capacity revealed a linear increase in solubility but an exponential increase in swelling capacity with a steady increase in temperature. Water absorption and oil holding capacities respectively, while the least gelation concentration, foaming volume increase, foaming stability, emulsifying capacity, and emulsion stability were high.

According to Kang and Lzzo (2011), lotus root quickly becomes brown and degrades, losing its culinary value. The results indicated that 0.006-0.07 mol/L citric acid treatment and 0.04-0.07 mol/L phosphoric acid treatment are both effective methods for lotus root preservation; however, 2 percent hydrogen peroxide processing for 10 minutes cannot prevent lotus root browning but can slow down decay.

Muhammad et al. (2011) investigated lotus rhizome flour grown in Pakistan's Southern Punjab. The temperature-dependent behavior of the flour's solubility and swelling capacity revealed a linear increase in solubility but an exponential increase in swelling capacity as the temperature increased. Water absorption and oil holding capacities were determined to be least gelation concentration, foaming volume increase, foaming stability, emulsifying capacity, and emulsion stability were determined.

Gani et al. (2013) observed that lotus stem when treated with gamma-irradiation at different doses, Carboxyl content, water absorption capacity, amylose leaching, and transmittance increased following the modification in a dose-dependent way, whereas swelling power, apparent amylose content, syneresis, and pasting properties declined. The X-ray diffraction pattern remained unchanged after irradiation, however there was a dose-dependent drop in relative crystallinity.

C. Functional and traditional foods rich in calcium and iron

Calcium is a mineral involved in a large number of vital functions. Although research on the role of calcium has been primarily focused on bone health, the effects of either dietary calcium or calcium supplements have been oriented towards other health outcomes lately (Ross et.al. 2011).

The 'nutraceuticals' are a group of food-derived compounds that are responsible for the functional properties of foods. Nutraceuticals have a variety of effects on human physiology, including gut health, antioxidant defenses, metabolic homeostasis, signaling systems, detoxification mechanisms, and other critical cellular activities (Kandlakunta et.al. 2016).

Functionality that is conventional Foods are made up of natural or whole-food elements that deliver functional substances, whereas modified functional foods or food products have additional ingredients added for specific health benefits. Vitamins, minerals, fiber, omega-3 fatty acids, antioxidants, and phenolic compounds included in plant-based foods such as fruits, vegetables, herbs, grains, nuts, and beans protect the human body against chronic diseases such as cancer, cardiovascular disease, and Gastro Intestinal Tract disease. (Arshad et.al. 2021).

Functional foods include a wide range of foods. Functional foods include minimally processed, whole foods, as well as fortified, supplemented, or enhanced foods. When ingested on a regular basis and at specific amounts, these foods have the potential to be good to one's health. (Ellis 2022).

The phytochemicals are bioactive compounds such as vitamins, carotenoids, phenolic acid, and flavonoids, which contribute to antioxidant capacity and as a whole prevent chronic non transmissible diseases such as: diabetes, high blood pressure, high cholesterol in blood, cardiovascular risks, among others (Neira et.al. 2017).

Instead of eating dietary supplements in liquid or tablet form, consumers can eat augmented foods that are closer to their natural state. India's lifestyle is increasingly westernizing, particularly in metropolitan areas, and this has been linked to an alarming rise in the prevalence of lifestyle-related health disorders. The Indian consumer is now looking for the food products that provide value beyond nutrition. (Mahdi et.al. 2016)

Chronic diseases (heart disease, cancer, and diabetes, for example) constitute a serious public health concern. A dietary pattern that is relatively heavy in fat, refined sugar, salt, and cholesterol is often the cause of such chronic disorders. The demand for healthy food products has expanded dramatically, as has societal interest in eating healthy foods. As a result, functional foods have gotten a lot of attention in the realm of food health and technology innovation. (Baker et.al. 2022)

D. Nutritional significance of lotus root and its incorporation in recipes

Nutritional analysis of was done (AOAC 2011) showed that moisture $3.370\pm 1.49g$, carbohydrate $86.56\pm 1.48g$, protein $1.02\pm 0.11g$, fat $9.01\pm 0.20g$, fibre $6.475\pm 0.25g$, ash $0.03\pm 0.075mg$, iron $1.908\pm 0.10mg$, phosphorus $13.63\pm 0.13mg$ and potassium $94.27\pm 0.19mg$ were more in treatments as compared to control. Cookies developed by incorporating lotus stem powder have good nutritional value (Zaidi et.al.2021)

Chen et.al. (2020) found that boiling the lotus rhizome enhanced the moisture and crude fibre content while decreasing the ash, crude fat, and crude protein levels. Meanwhile, deep frying the lotus rhizome decreased moisture while increasing ash, crude fat, crude protein, crude fiber, and carbohydrate content. Boiling significantly reduced the amount of vitamin C while deep frying caused a significant reduction in total phenolic content, total flavonoid content and antioxidant activity for both (2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid)) ABTS and Di Phenyl Picryl Hydrazyl (DPPH) assays of lotus rhizome.

According to Saeed et al. (2021) examined the effect of substituting lotus root flour (LRF) for wheat flour (WF) at various concentrations on functional properties, rheological characteristics, antioxidant activity, total phenolic content (TPC), physical properties,

nutritional profile, and sensory attributes on flour and unleavened flatbread samples was investigated. The findings revealed that flour blends had a lower gluten content, which coincides with the high water absorption (WA) of LRF, which interferes with the establishment of the gluten network.

Lotus root contains no cholesterol and has a low calorie count. Lotus root contains a special blend of vitamins, minerals, and nutrients that are extremely useful to our health. Potassium, phosphorus, copper, iron, and manganese are minerals found in lotus root, as are vitamins like thiamine, pantothenic acid, zinc, and vitamin B6. Lotus root also has good quantities of dietary fiber and protein (Firdous 2020)

Li et al. (2021) stated that after 12 weeks of 30% LWIF administrating, the fast blood glucose of diabetic rat decreased from 17.6 to 5.8 mmol/L together with the reduction of serum TC, TG and LDL-C. The hepatic histopathological examination and serum levels changes of SOD, CAT and FFA confirmed LWIF could effectively protect the liver of the diabetic rats from damage caused by oxidative stress.

Ma et al. (2021) investigated the use of a hot-air coupled microwave to dry lotus root slices. The drying kinetics of lotus root slices were examined using eleven different methods. Regardless of drying conditions, the effective diffusivity coefficients ranged from 8.23×10^{-7} to 7.08×10^{-6} m²/s, and their variations were mostly in agreement with those of moisture ratios. The activation energy of moisture diffusion related to lotus root slices was determined to be 13.754 kJ/mol.

Thai lotus seeds have been widely utilized for both food and medicine, according to Singthong (2017) Thai lotus seed flours had a high carbohydrate, protein, and amylose content. These flours have excellent water and oil absorption capabilities, as well as protein solubility, emulsion, and foaming qualities. When heated, the pasting properties were somewhat altered. When incorporating 10% lotus seed flour in bread, both the bread quality and consumer acceptance were improved.

Du et al. (2012) investigated the antioxidant and hepatic protective effects of lotus root hot water extract combined with taurine supplementation in obese rats fed a high-fat diet. Lotus root hot water extract was orally administrated to HFR and HFRT groups and the same amount of distilled water was orally administered to N and HF groups. Thiobarbituric acid reactive substance contents in all groups fed a high fat diet were higher compared to N group. The

activities of hepatic antioxidant enzymes were higher in HFR and HFRT groups compared to HF group.

According to Shukla et al. (2017) coliform, *Bacillus cereus*, *Escherichia coli*, *Salmonella* and *Staphylococcus aureus* counts were not detected in majority of the samples, confirming the high degree of hygiene processing of lotus root fermented sugar syrup samples for its use as a food supplement or condiment.

The lotus root is a vegetable root with therapeutic benefits. It has been used in Asian traditional medicine for centuries. Lotus root benefits the health in a number of ways, thanks to its rich nutrition profile. It is a great source of carbohydrates, fiber, and antioxidants that help treat many ailments. This nutritional food source is used to add seasoning to foods and has several culinary applications too (Karnik 2022)

Muhammad et al. (2020) attempted to use lotus as a fat mimetic in the creation of functional cookies. Gluten content dropped as Lotus Root Flour concentrations increased, implying a weaker gluten network, which was corroborated by scanning electron microscopic images of biscuit dough. The total phenolic content, DPPH radical scavenging activity-IC₅₀, and ferric reducing antioxidant power-IC₅₀ increased upon increasing the content of LRF in wheat flour and biscuits samples. Nutritional data revealed that protein ash and the crude fiber content of biscuits increased, and calories reduced.

According to Hajela et al. (2019) the rhizomes of the lotus plant include 1.7 percent protein, 0.1 percent fat, 9.7% carbohydrate, and 1.1 percent ash. Calcium, iron, and zinc concentrations in the stem area are 6, 2.4, and 0.2 mg/100 g, respectively. The mature seeds of *N. nucifera* include 8-10% moisture, 25% protein, 3.7 percent crude fat, 65 percent carbohydrate, 3-4 percent crude fiber, and 4% ash, with 388 calories per 100 grams of energy. The lipid content of Lotus seed flour is 19.50 mg/g polyunsaturated fatty acids and 5.05 mg/g saturated fatty acids oleic, where linoleic is the most abundant.

According to Sruthi et al. (2019) showed that bioactive compounds identified by HR-LCMS from rhizome of *Nelumbonucifera* have revealed a very good potential to be explored as food supplements or even pharmaceutical products to improve human health.

Wasagu et al. (2015) used established procedures to assess the nutritional composition, ant nutritional components, and elemental analysis of three parts of *Nymphaea lotus*. Both ant nutritional agents and heavy metals are present in moderate amounts. The vitamin E level of

the seeds sample was high, whereas the other vitamins found were present in all plant components.

Takefumi et al. (2012) investigated the cytoprotective effect of an aqueous extract made from a lotus root. Lotus root extract is thought to include unique substance(s) that protect glial cells from oxidative assaults caused by iron. The preservation of brain function through the protection of neuronal cells and glial cells from toxic assaults is thought to be advantageous in the prevention of neurodegenerative illnesses.

Bedi et al. (2006) have reported that the highest iron concentration was found in lotus root (60.mg/100g), while the lowest was found in sweet potato (2.8mg/100g). Alkaloids (demethylcolaurine, isoliensinine, liensininelotusine, methylocrpalline, neferinenuciferine, pronuciferineflavoinds (galuteoline, hyperine, rutin) and microelements (galuteoline, hyperine, rutin) are abundant in Lotus seeds (zn, fe,ca,and Mg).

METHODOLOGY

III. METHODOLOGY

The Methodology of the research titled “Evaluation of Acceptability and Nutritive Value of Recipes Incorporated with Lotus Root Powder” was conducted in four phases and is presented as follows.

Phase I: Elucidating information regarding use of lotus root powder in the daily diets of general population.

Phase II: Preparation of Lotus Root for incorporation and Nutritional Analysis

Phase III: Recipe development and Evaluation of acceptability.

Phase IV: Promotion and creating awareness on the developed recipes

The approval for the proposed study was obtained from the Institutional Human Ethics Committee (IHEC) of Avinashilingam Institute for Home Science and Higher Education for Women with approval number AUW/IHEC/FSMD-21-22/XPD-24 and is given as Appendix-I. Flow chart of Methodology is presented in

Figure 1.

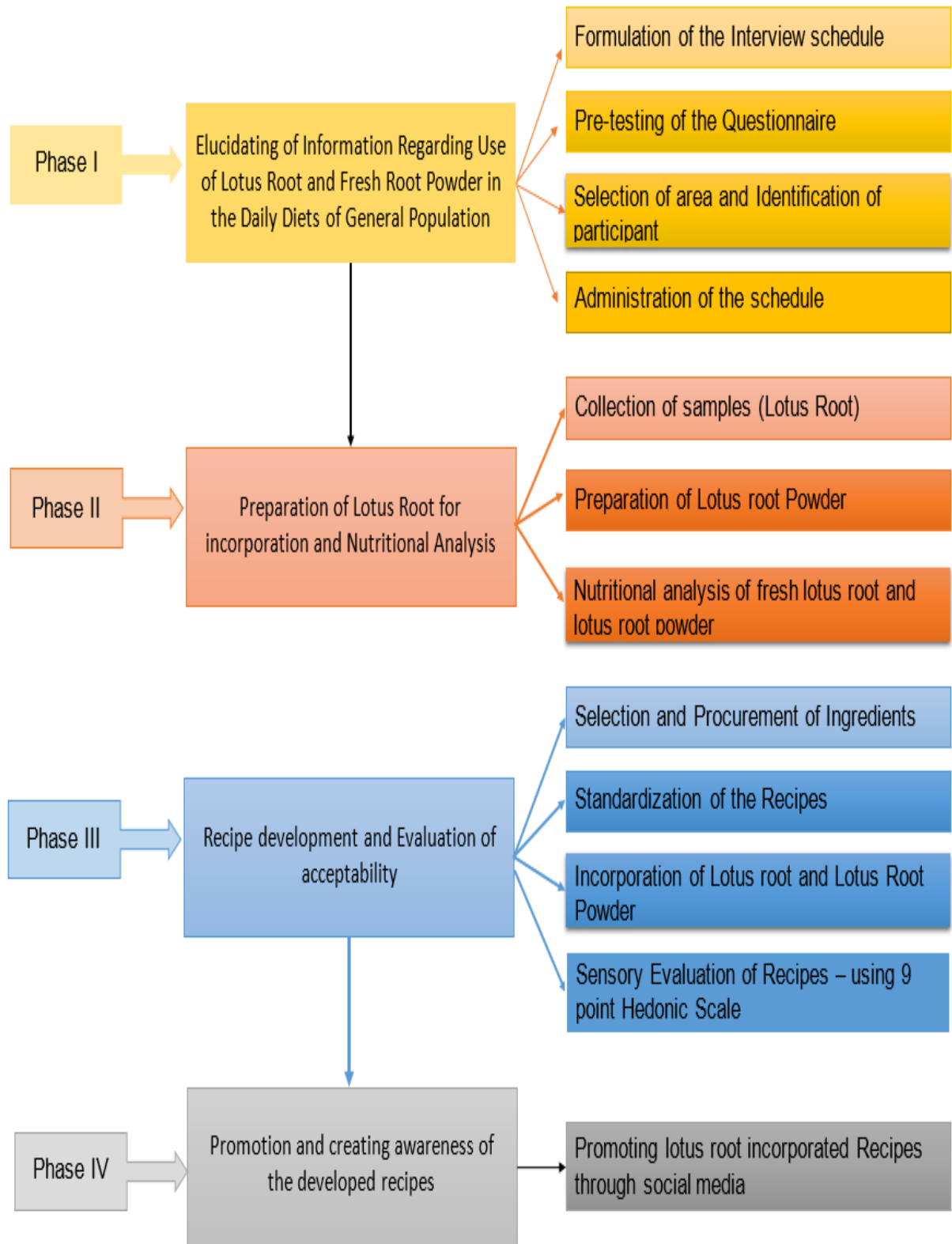


Figure 1: Flow Chart of Research Design

Phase I Elucidating of Information Regarding Use of Lotus Root and Fresh Root Powder in the Daily Diets of General Population

This phase entailed interacting with the community in order to find out the broad awareness about the use of lotus root powder within the population group.

A) Formulation of the Interview schedule

An interview schedule consisting of questions to draw the information pertaining to the socio-economic background, dietary practices, and inclusion of functional/novel foods in their diets was structured. The possible causative factors for the preference & recipes prepared with lotus root were also identified.

B) Pre-testing of the Questionnaire

The schedule was specially examined by the academicians & later revised in the light of the suggestions made by them. Next in order, the first draft of the structural personal interviewing instrument was used for pre-testing over 10% of the sample size. These were from non-sampling population. The observations were recorded, tabulated & analyzed. Based on the results of this analysis, the instrument was edited & finalized for collecting the information.

C) Selection of area and Identification of participant

The adult residents of Coimbatore city from different area were included in the study. The selection criteria of the subjects was-

- 1) easy access, availability and co-operation
- 2) homogenous income group
- 3) Both genders from different age groups were interviewed.

A group of 50 people who were willing to participate in the study were selected by random sampling for eliciting information like knowledge of lotus root, its uses and different preparations and products prepared with it.

D) Administration of the schedule – The questionnaire was administered to the subjects through personal interview, keeping in mind the advantages:

- i) The first hand information obtained is bound to be reliable and authentic.
- ii) The doubts in the minds of the respondents were removed while answering

iii) When the audience is approached personally, the response is likely to be more encouraging.

General information or instructions were also given to the subjects who were ignorant to the food item studied.

Phase-II Preparation of Lotus Root and Lotus Root Powder for incorporation and Nutritional Analysis

A) Preparation of Lotus Root Powder

The lotus root for the study was collected from a retail supplier in Coimbatore district of Tamil Nadu. The collected fresh Lotus root was kept in bucket of domestic water and for cleaning the Lotus root cutting method were used to remove root nodules at edges of the lotus root and peeled the outer skin of the selected lotus root. The peeled lotus root was sliced into thin pieces.

The cut pieces were washed again with clean water and drain excess water from roots and kept in a clean and dry tray with tissue papers beneath and top of the clean pieces for drying completely and shade dried. The tissue was changed frequently whenever it got wet due to the water content of Lotus root and when the process was not carried out, black colour fungal mold growth was observed. So this tissue drying process of Lotus root was done with utmost care. The shade drying process was done for a 10 to 12 days duration, depending on the moisture content of the lotus root (Plate I).

The lotus root changed its colour to brown due to oxidation and turned hard and crispy when completely dried and then ready for the preparation process. The collected dried lotus root slices were transferred to a clean and dried mixer jar for powdering.

The dried lotus root was powdered until it turned into fine powder and was sieved to avoid any large particles in it. Also it is very important to store lotus root powder in clean, sanitized and dry air tight container to avoid spoilage .The collected fine lotus root powder was used for incorporation into the recipes as per the measurements.



1. Fresh Lotus Root



2. Sliced Fresh Lotus Root



3. Shade dried Lotus Root



4. Powdered Lotus Root

Plate 1: Preparation of Lotus Root Powder

B) Nutrient analysis

The freshly collected lotus root and the prepared powder were analyzed for moisture and nutrients, namely, Vitamin C, Calcium and Iron adopting standardized procedure.

Analysis of Lotus Root and Lotus Root Powder

1. Moisture:

Weighed accurately 5 gm of sample in a previously dried and tared dish and placed the dish with its lid underneath in the oven for 3 hours. The time should be reckoned from the moment the oven attains 103°C after the dishes have been placed. Removed the dishes after 3 hours, cooled in the desiccators and weighed. The dishes were placed back in the oven at half hour intervals till constant weight was achieved.

Calculation

Moisture percent = $(W1 - W2) \times 100 / W1 - W$

Where, W1 = Weight in gm of the dish with the material before drying W2 = Weight in gm of the dish with the material after drying

W = Weight in gm of the empty dish.

2. Iron and Calcium:

Sample preparation: Weighed accurately 0.5-1.0g of well homogenized sample into a clean silica dish. Dried the contents at 110°C. Transferred the dish into muffle furnace and slowly increased the temperature to 550°C. Ashed the contents for about 3 hours till the ash turns white or brownish red. Washed down the sides of the dish with water and added 7ml HNO₃ and mixed well. Dried on hot plate. Repeated nitric acid treatment using 1ml increments till white / brownish red carbon free ash was obtained. Make up the solution to 100ml with 2% HNO₃ reagent.

Preparation of Standard Curve: Prepared a reagent blank and a series of standard containing 0.1,1.0,10.0,mg/L of standard solution by diluting a suitable volume of standard solution with dilute Nitric acid. Measured the emission spectra and constructed a standard calibration graph by plotting Intensity vs mineral concentration.

Calculation:

Calculated the concentration C of mineral in the test sample according to the formula

$$C = \frac{(A-B) * V}{M}$$

Where, C is the concentration of mineral in the test sample

A is the concentration in the test solution (mg/l)

B is the concentration in the blank solution (mg/l)

V is the Volume make up of test Solution

M is the weight of sample for analysis in g

3. Vitamin – C

Took 1gm sample and dissolved in 50ml of water into a 250 mL conical flask and added about 100 mL of distilled water and 1 mL of starch indicator solution. Titrated the sample with 0.005 mol L⁻¹ iodine solution. The endpoint of the titration is identified as the first permanent trace of a dark blue-black colour due to the starch-iodine complex. Repeated the titration with further aliquots of sample solution until concordant results are obtained (titres agreeing within 0.1 mL).

1ml of Iodine mol/L equivalent to 0.88 mg ascorbic acid or vitamin C.

At the end point of titration $C_1 V_1$ of iodine = $C_2 V_2$ of ascorbic acid

$$\text{Weight of ascorbic acid (mg/100g)} = \frac{\text{Volume (ml)} \times \text{Concentration} \times \text{M.W of ascorbic acid}}{\text{Weight of the sample in mg}} \times 100$$

Phase – III Recipe Development and sensory analysis

Five recipes were selected of which pickle and pakoda were prepared using fresh root and peanut chocolate, cookies and jam were prepared by incorporating lotus root powder in the standard recipe. The recipes was chosen for the following reasons

1. These recipes are suitable for all age groups
2. These recipes have wide acceptability among the general population

3. The recipes are easy to prepare.
4. Except pakoda, the other four prepared recipes will have a good shelf life.

A) Selection and Procurement of Ingredients

The ingredients for the recipes prepared in the present study were purchased from retail suppliers in Coimbatore district of Tamil Nadu.

B) Standardization of the Recipes

The selected recipes were standardized using Trial and Error method. They were used as control against the variations incorporated with lotus root powder. For fresh lotus root recipes the recipes were prepared without any variation whereas for recipes incorporated with lotus root three variation were developed as given in Table I.

Table I

Variations of Incorporation of Lotus Root Powder

Variations	Lotus Root Powder (g)
Variation I	10g
Variation II	15g
Variation III	20g

The composition of recipes developed using fresh lotus root is presented in Table II and Table III

1. Pakoda

Table II

Composition of Pakoda prepared with Fresh Lotus Root

INGREDIENTS	QUANTITY
Lotus root	100g
Corn starch	5g

Gram flour	10g
Green chilli paste	5g
Ginger garlic paste	5g
Red Chilli powder	5g
Turmeric powder	2g
Salt	3g
Refined oil	50ml

Pakoda is a very commonly prepared snack and can be easily prepared at home. It is usually prepared with onion covered in gram flour batter. In this recipe onion in the standard recipe was replaced with fresh lotus root.

2. Pickle

Table III

Composition of Pickle Prepared with Fresh Lotus Root

INGREDIENTS	QUANTITY
Lotus root	100g
Mustard	4g
Fenugreek seeds	2g
Fennel seeds	2g
Chilli powder	4g
Turmeric powder	2g
Vinegar	3ml
Oil	40ml
Salt	2g

Pickle is a very commonly prepared side dish and is widely used in Indian cuisines. It is usually prepared with lemon, mango, garlic, and a few vegetables. In this recipe the major ingredient in the standard recipe was replaced with fresh lotus root.

The composition of recipes prepared with incorporating dried lotus root powder with the variation is presented in Tables IV, V and VI.

3. Peanut chocolate

Table IV

Composition of Peanut Chocolate Incorporated with Lotus Root Powder

INGREDIENTS	QUANTITY			
	STANDARD	VARIATION -I	VARIATION - II	VARIATION-III
Peanut	40g	40g	40g	40g
Sugar	80g	80g	80g	80g
Butter	10g	10g	10g	10g
Whipping cream	40g	40g	40g	40g
Dark Chocolate	40g	40g	40g	40g
Refined oil	2ml	2ml	2ml	2ml
Salt	1pinch	1pinch	1pinch	1pinch
Lotus root powder	0	10g	15g	20g

Peanut chocolate is the most preferred sweet by all age groups. It will a good replacement for the chocolate bars with healthy ingredients like lotus root and peanuts. In this recipe lotus root powder is added with the normal ingredients as give in Table IV.

4. Mixed Fruit jam

Table V

Composition of Mixed Fruit Jam Incorporated with Lotus Root Powder

INGREDIENTS	QUANTITY			
	STANDARD	VARIATION-I	VARIATION-II	VARIATION-III
Pomegranate	10g	10g	10g	10g
Orange	10g	10g	10g	10g

Papaya	10g	10g	10g	10g
Apple	10g	10g	10g	10g
Green grapes	10g	10g	10g	10g
Black grapes	10g	10g	10g	10g
Sugar	90g	90g	90g	90g
Lemon juice	2ml	2ml	2ml	2ml
Lotus root powder	0	10g	15g	20g

Jam is the important and favorite food for children and also adults. Fruits Jams are more popularly prepared with single or mixed fruit. In this recipe jam is made by using mixed fruits along with lotus root powder in varying quantities of 10g, 15g and 20g.

5. Cookies

Table VI

Composition of Cookies Incorporated with Lotus Root Powder

INGREDIENTS	QUANTITY			
	STANDARD	VARIATION-1	VARIATION-2	VARIATION-3
All-purpose flour	100g	90g	85g	80g
Butter	60g	60g	60g	60g
Sugar	20g	20g	20g	20g
Vanilla essence	2ml	2ml	2ml	2ml
Lotus root powder	0	10g	15g	20g

Cookies are a favorite family snack especially among kids usually made up of Maida/ Wheat flour, and also Millet flour. Cookies were prepared with the replacement of major ingredient (All-purpose flour) by 10g, 15g and 20g of lotus root powder in the variation I, Variation II and variation III respectively.

C. Sensory Evaluation of Recipes

The Sensory evaluation was done using a nine-point hedonic scale for rating the attributes like texture, colour, consistency, flavor, appearance and overall acceptability. The recipes were evaluated by a trained panel of 20 members and they were given score cards as represented in Table VII. Zaidi et al. (2021) was also evaluated the sensory evaluation of the product using the Nine Point Hedonic Scale of flavor for the product cookies.

Table VII
Score Card for Sensory Evaluation

Grading categories		Attributes					Overall acceptability
		Appearance	Texture	Flavour	Taste	Colour	
Like	Extremely						
	Very much						
	Moderately						
	Slightly						
Neither like nor dislike							
Dislike	Extremely						
	Very much						
	Moderately						
	Slightly						

Numerical scores were assigned to each attributes from 1 to 9 ,that is, like extremely – 9, like very much – 8, like moderately – 7, like slightly – 6, neither like nor dislike – 5, dislike slightly – 4, dislike moderately – 3, dislike very much – 2, and dislike extremely –1. Mean acceptability scores was calculated for standard and variations.

D. Texture Analysis:

The most acceptable variation as evaluated by sensory analysis for two recipes namely peanut chocolate and cookies were analysed for their hardness and adhesiveness using a texture analyser (Shimadzu, EZ-SX Short Model) along with their standard.

E. Nutrient Content of the recipes:

The nutritive value of each recipe were calculated according to Indian Food Composition Table (IFCT, 2017)

Phase IV

Promotion and Creating awareness on the developed recipes.

Promotion and awareness on the developed product was made in Instagram, YouTube and WhatsApp. Awareness was given on

- Health benefits of lotus root.
- Nutrient content of lotus root.
- Preparation of the developed recipes.

RESULTS AND DISCUSSIONS

IV. RESULTS AND DISCUSSION

The findings of the study titled “**Evaluation of Acceptability and Nutritive Value of Recipes Incorporated with Lotus Root Powder**” are presented under the following headings

- A. Awareness on lotus plant parts as food
- B. Acceptability of developed recipes
- C. Nutritive value of lotus root fresh, root powder and developed recipes
- D. Promotion of recipes developed with Lotus Root

A. Awareness on lotus plant parts as food

1. Socio-Demographic profile of the respondents

a) **Age:** The percentage distribution of the respondent’s age wise is presented in Figure 2.

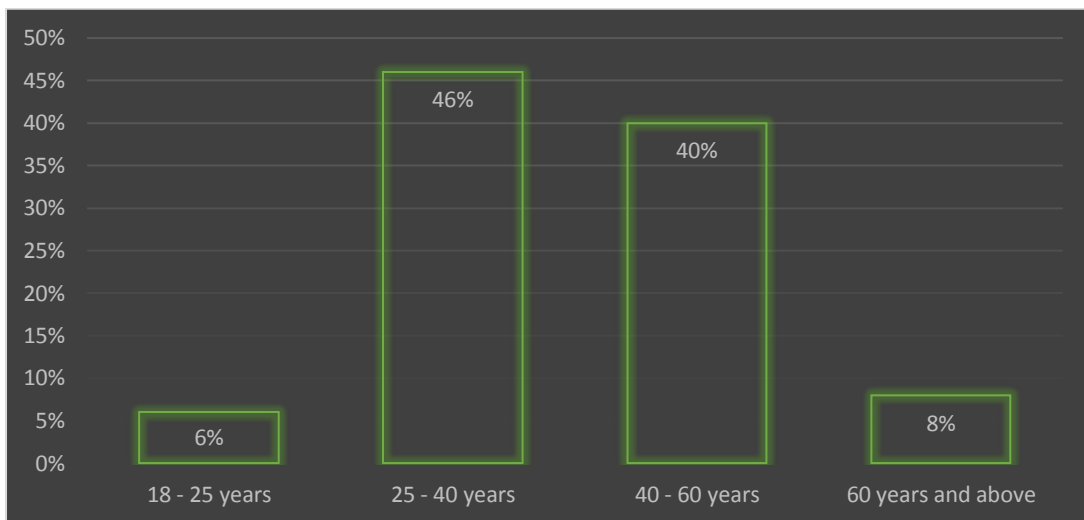


Figure 2: Percentage Distribution of Respondent’s Age Wise.

From the above Figure 2 the age wise distribution of the sample respondents can be identified. It was observed that 46 percent were from age group of 25 to 40 years followed by 40 percent between the ages of 40 to 60 years whereas 8 percent were from 18 – 25 years and 8 percent were from age of 60 years and above.

b) **Gender**

The gender wise distribution of the respondents as presented in Figure3. As seen in the Figure 70 percent of the respondents were females only 30 percent were males.

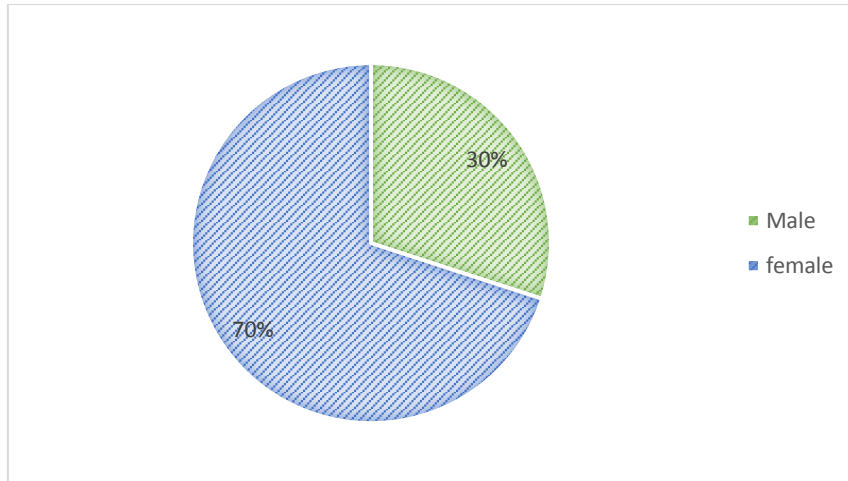


Figure 3: Gender Wise Distribution of Respondents

c) Marital status

The marital status of the respondents is presented in Table VIII

Table VIII

MARITAL STATUS OF RESPONDENTS (N=50)

Marital status	Total
Married	45
Widow	2
divorce	3
Total	50

The marital status of the selected sample group showed that 45 were married, 3 were divorcees and 2 were widows.

d) Type of Family

The type of family of the respondents is presented in Table IX

Table IX

Family Type of Respondent (N=50)

Family type	Number	Percentage
Nuclear	39	78
Joint	8	16
Extended	3	6
Total	50	100

The type of family in which the respondents belonged to showed that 78 percent were living in nuclear family followed by 16 percent residing in joint family type and only 6 percent belonged to extended family. Thus a majority were living in a nuclear family.

e) Family size

The Family size of respondents is presented in Table X

Table X
Family Size of Respondents (N=50)

Family size	Numbers	Percentage
2-4	43	86
4-6	3	6
Above6	4	8
Total	50	100

Information on family size of the respondents showed that 86 percent of the respondents had family members between 2 to 4 and 8 percent of the population had family members above 6 and 6 percent had family members between 4 to 6.

f) Education

The education status of the respondents is presented in Figure 4. Details on the education of the respondents showed that about 36 percent of the study population have obtained education up to high school followed by 24 percent of the population have done post-graduation whereas 18 percent were graduates.

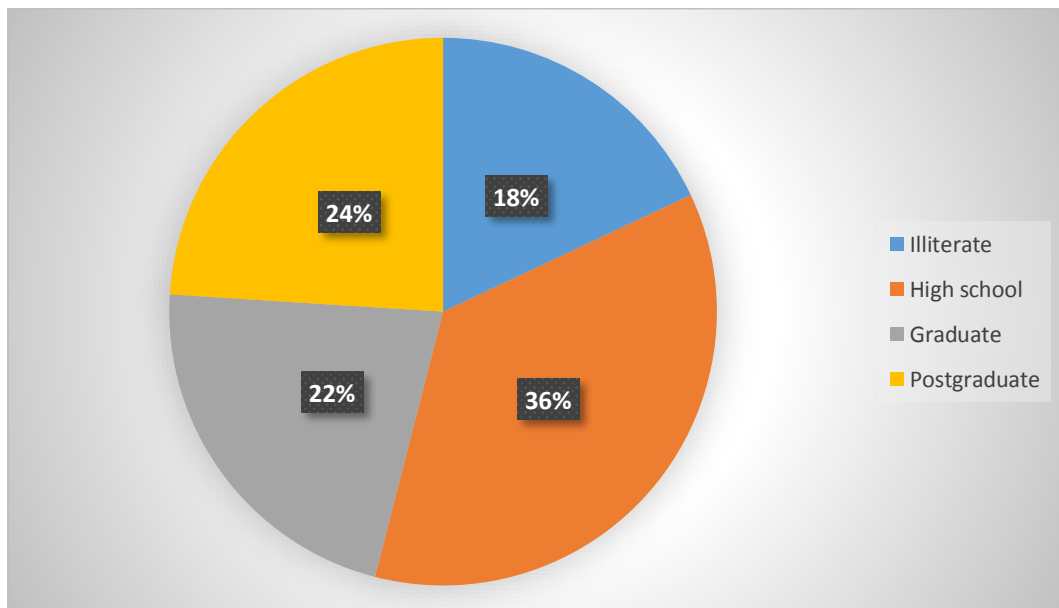


Figure 4: Education Status of the Respondents.

g) OCCUPATION:

The occupation of the respondents is present in Table XI

Table XI

Occupation of the Respondents

Occupation	Number	Percentage
Private sector	9	18
Public-sector	8	16
Self employed	6	12
Home maker	8	16
unemployed	19	38
Total	50	100

The occupation status of the respondents showed that about 38 percent (N=19) of the sample were unemployed followed by 18 percent (N=9) working in private sector as employees and 16 percent were in public sector working as employee in government sectors like transport, sanitation department and 12 percent were self-employed and 16 per cent of the respondents were home makers.

h) Income level of respondents

The income level of respondents is presented in Table XII.

Table XII

Income Level of Respondents

Monthly Income	Total	Percentage
Below 20000	29	58
20000-30000	15	30
30000-40000	5	10
Above40000	1	2
Total	50	100

Income of the sample group showed that about 58 percent were receiving a monthly income below Rs.20000 followed by 30 percent receiving income between Rs.20000 to Rs.30000 whereas other received income above Rs.30000. Out of the 50 respondents, 50% were unemployed and earning below Rs.20,000 per month and the remaining were educated

and had good monthly income. Hence the investigator had included respondents from all sections.

2) General Dietary Information and Awareness on Lotus Plant on Food

The eating habit of the selected population showed that 64 percent were non vegetarian followed by 25 percent being vegetarian and 10 percent being ovo vegetarian.

Information regarding intake of health supplements among the respondents showed that 29 respondents did not consume any healthy supplement and 21 were taking some kind of health supplements. Four respondents were consuming Vitamin D supplements as capsules, 12 were taking multi vitamin supplements as capsules and tonics and five were consuming probiotic supplements as powder belonging to commercial brands.

Regarding the consumption of herbal products 12 of the respondents were consuming herbal products like herbal tea, kashayam and immune boosting powder.

Data on awareness on traditional plant food with health benefits among the respondents showed that 76 percent were not aware of any kind of foods and only 24 percent had some kind of awareness on eating millets and green leafy vegetables.

Regarding the consumption of uncommon foods only Nine respondents were consuming uncommon foods like concoction similar to Ayurvedic preparations like rasam and kashayam.

3. Awareness on Edibility

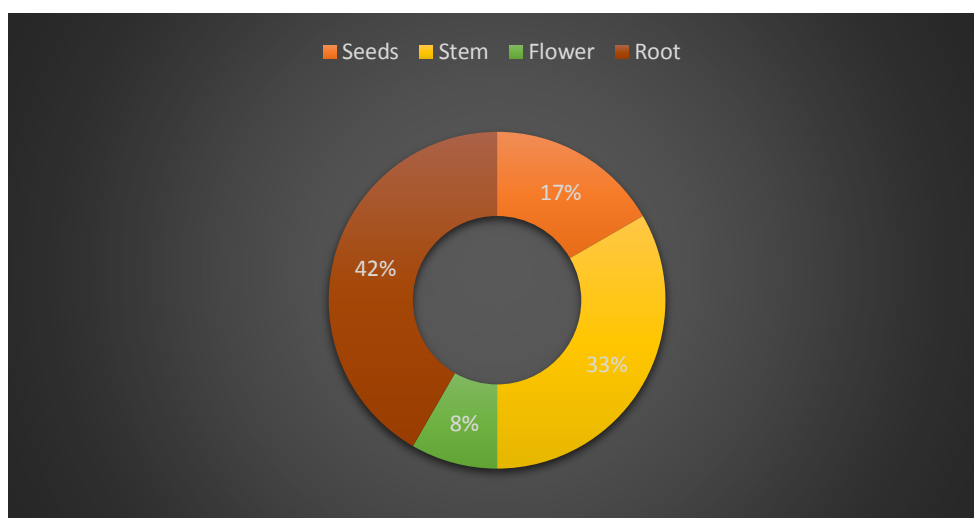


Figure 5: Awareness on Edibility of Lotus Plant Parts

Only 28 percent (N=12) of the respondents had awareness that parts of the lotus plant like root, stem, seeds were edible of them. Five had the awareness that lotus root can be eaten. The other respondents 76 (N=38) did not have any knowledge on the edibility of lotus plant and parts.

The data on awareness on how the lotus plant parts can be consumed that 84 percent has the knowledge that it can be cooked and consumed whereas 16 percent said that it can be consumed half cooked.

The respondents who were unaware of the edibility were told that it was edible and were asked about their preference of cooking and consuming it. Information on preference of consuming lotus root showed that twelve respondents preferred to consume lotus root as chips while others had no idea.

Data on awareness of nutritional benefits of lotus root revealed that 94 % (N=47) had no knowledge on their aspects and the remaining them of the respondents had some knowledge gathered through media, books, family and friends.

Responses regarding the most preferential factor to choose such novel foods for consumption revealed that social media has a great influence followed by awareness on Nutritional benefits and taste of the product or recipes.

The limited factors for avoiding novel foods as reported by the respondents would be unavailability of the food followed by the cost of the food and unfamiliarity of the taste and doubts on edibility of the food.

Forty three of the respondents showed their willingness to incorporate lotus root powder in daily pre-preparation and from the suggestions received a few recipes like pakoda, chips, sambar powder, curry powder, rasam powder, peanut bar, and biscuits were suggested more by the respondents.

The data revealed that the respondents were a mixed population belonging to varied income level and with varied educational status. Their knowledge on lotus plants parts as food was limited but were willing to incorporate it in their diet considering the nutritional benefits of the food.

B) Acceptability of the developed recipes

1. Physical attributes of lotus root powder

The physical attributes of Lotus Root Powder is presented in Table: XIII

Table XIII

Physical Attributes of Lotus Root Powder

S.No	Attribute	Observation
1	Appearance	Free Flowing powder
2	Colour	Mud Colour
3	Odour	Acceptable
4	Taste	Bland

The physical attributes of the prepared Lotus root powder was analyzed. The appearance of Lotus root powder was free flowing powder with mud color and the odor was acceptable and it tasted bland. Park and Cho (2009) formulated Jook with lotus root powder and its Sensory characteristics, such as color intensity, viscosity, nutty taste, and off-flavor increased significantly with the addition of Lotus root powder.

2. Acceptability of lotus root Pakoda

The Pakoda prepared from Lotus Root was evaluated for their sensory characteristics and the data is presented in Table XIV

Table XIV

Sensory Evaluation Score of Lotus Root Pakoda

Name of the Recipe	Appearance	Colour	Texture	Flavour	Taste	Overall Acceptability
Pakoda	8.3±0.48	8.5±0.53	8±0.82	8.1±0.74	8.5±0.53	8.28±0.38

From the above table it is evident that all the attributes had mean scores of eight and above showing that the recipe was liked very much in terms of appearance, texture, flavor, taste and over all acceptability. The recipe is presented in Plate 2.

Lotus Root Pakoda



Lotus Root Pakoda



Sensory Evaluation

Plate 2: Sensory Evaluation of Lotus Root Pakoda

3. Acceptable of lotus root Pickle (Table XV)

The Lotus Root Pickle was evaluated for their sensory characteristics and the data is presented in Table XV

Table XV

Sensory Evaluation Scores for Lotus Root Pickle

Name of the Recipe	Appearance	Colour	Texture	Flavour	Taste	Overall Acceptability
Pickle	8.4±0.52	8.4±0.52	8±0.87	8±0.47	8±0.67	8±0.82

The sensory evaluation scores of fresh Lotus root for pickle for appearance and colour has mean value of 8.4, texture and taste had 8 and the overall acceptability score was above 8. Hence the recipe had a liked very much score for acceptability. The prepared recipe is present in Plate 3.



Lotus Root Pickle



Sensory Evaluation

Plate 3: Sensory Evaluation of Lotus Root Pickle

4. Acceptability of Jam

Jam prepared by incorporating Lotus Root Powder in three variation and were subjected to sensory evaluation and the scores are presented in figure 6

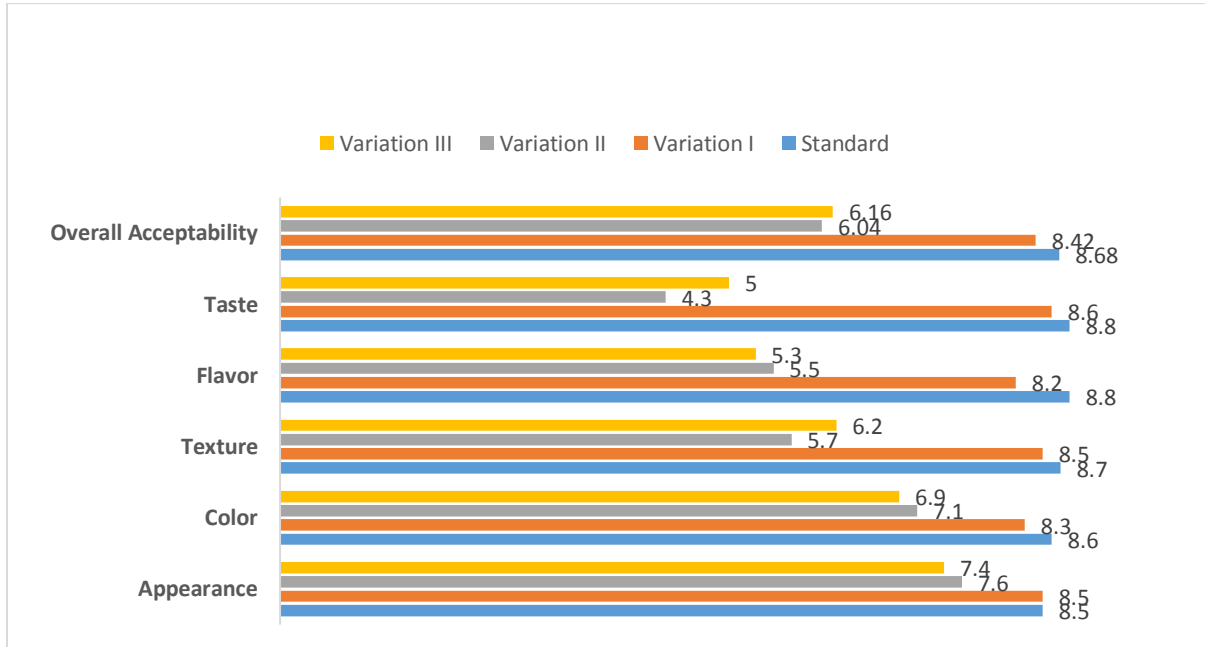


Figure 6: Sensory Evaluation Score for Jam

Among the three variations, variation I in which 10 g of lotus root powder was incorporated received the highest score for all the attributes. The higher quantity of the powder in variation II and III decreased the sweet taste and flavor of Jam and hence received low scores and also affected the appearance and color of Jam.

Compared with the standard, variation I received slightly less scores for taste, texture and overall acceptability but the mean scores for all the attributes was above 8 showing that the recipe was liked very much.

The Jam recipe with variation is presented in Plate 4



Standard



Variation I



Variation II



Variation III



Sensory Evaluation

Plate 4: Sensory Evaluation of Jam

The test of significance done for the standard and the most acceptable variation I, showed that there is a significance difference in the score at 1% level of significance. The mean acceptability of standard was 8.7 ± 0.34 and that of variation I was 8.4 ± 0.65 .

5. Lotus root Peanut Chocolate

The sensory evaluation scores of lotus root peanut chocolate is presented in Table XVI and Figure 7

Table XVI

Sensory Evaluation Score of Lotus Root Peanut Chocolate

	Appearance	Color	Texture	Flavor	Taste	Overall Acceptability
Standard	8.2±0.63	8.6±0.52	8.1±0.74	8.2±0.63	8.7±0.67	8.36±0.47
Variation I	8.7±0.48	8.5±0.53	8.7±0.48	8.6±0.52	8.6±0.52	8.62±0.24
Variation II	7.5±1.43	7.9±1.10	6.6±0.84	6.3±1.49	6.2±0.79	6.9±0.86
Variation III	6.2±0.92	6.8±1.14	6.7±1.16	6.3±1.06	5.4±1.35	6.28±0.92

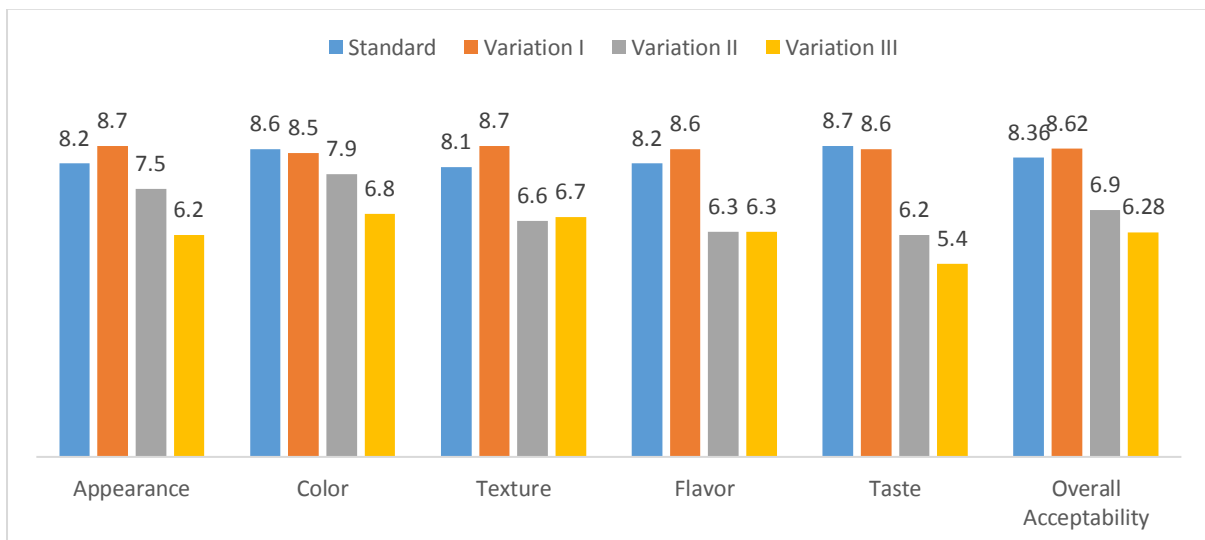


Figure 7: Sensory Evaluation Score of Peanut chocolate

The scores received for appearance, colour, texture, flavour and taste of the variation 1 with 10g of lotus root powder was higher than the standard recipe. Variation 1 had the highest score of 8.7 for appearance and texture. It had the highest overall acceptability among the variations at 9 which meant it was liked extremely. This was because of the taste and flavor of peanut bar. Whereas in variation 2 and 3, the increased content of the lotus root powder dominated flavor and taste that resulted in low overall acceptability when compared with variation 1.

The recipe prepared is presented in plate 5



Standard



Variation I



Variation II



Variation III

Lotus Root Peanut Chocolate



Sensory Evaluation

Plate 5: Sensory Evaluation of Peanut Chocolate

The test of significance done for the standard and the most acceptable variation I, showed that there is a significance difference in the score at 1% (appearance and texture) and 5% (colour, flavour, taste and overall acceptability) level of significance. The mean acceptability of standard was $8.4 \pm .47$ and that of variation I was $8.6 \pm .24$.

Texture Analysis

The standard recipe and the most acceptable variation (variation I) of peanut chocolate were analysed for hardness and adhesive force using a texture analysis and the results are presented in Table XVII

Table XVII

Texture Analysis of Peanut Bar

Criteria	Standard	Variation I
Hardness	1.05445 N	1.80602 N
Adhesive Force	0.01041 N	0.01852 N

The hardness and adhesiveness increased after incorporation. The increase in hardness was significant, whereas the adhesiveness did not change much.

The peak values obtained for standard and variation I are presented in figure 8 and figure 9 respectively.

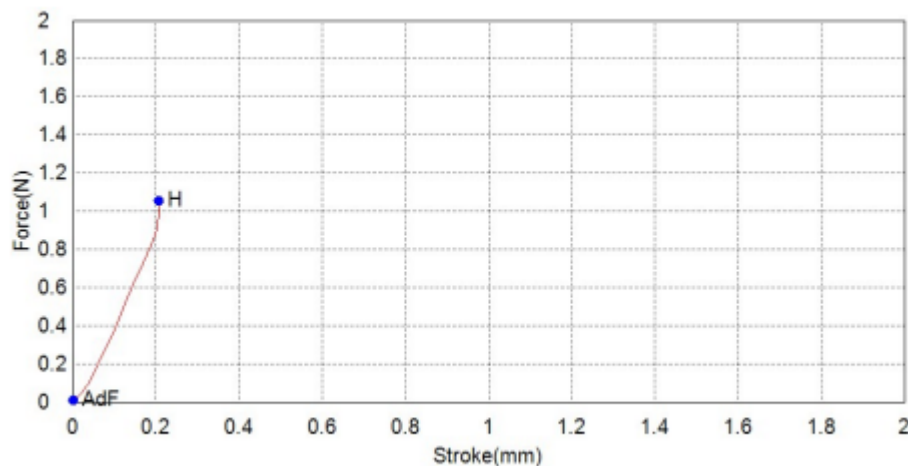


Figure 8: Peak Values for Texture Standard Peanut Chocolate

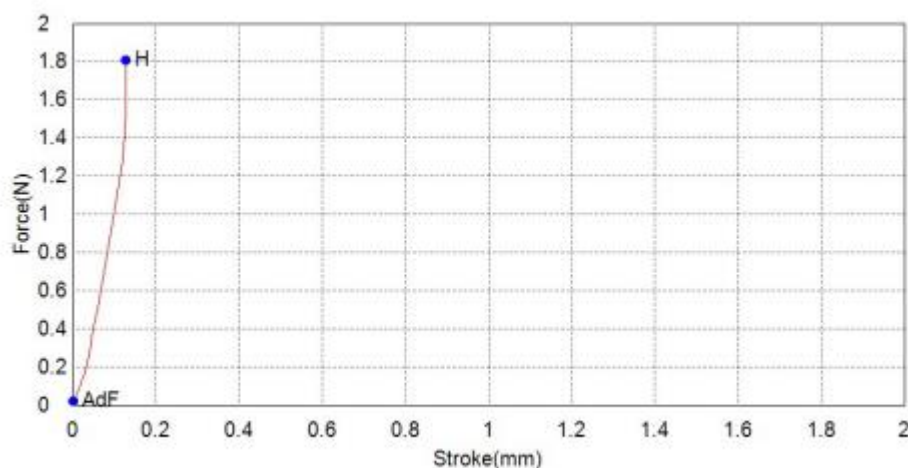


Figure 9: Peak Values for Texture Variation I Peanut Chocolate

6. Acceptability of Lotus Root Cookies

The scores obtained for cookies prepared with Lotus Root Powder along with the standard recipe are presented in table XVIII

Table XVIII

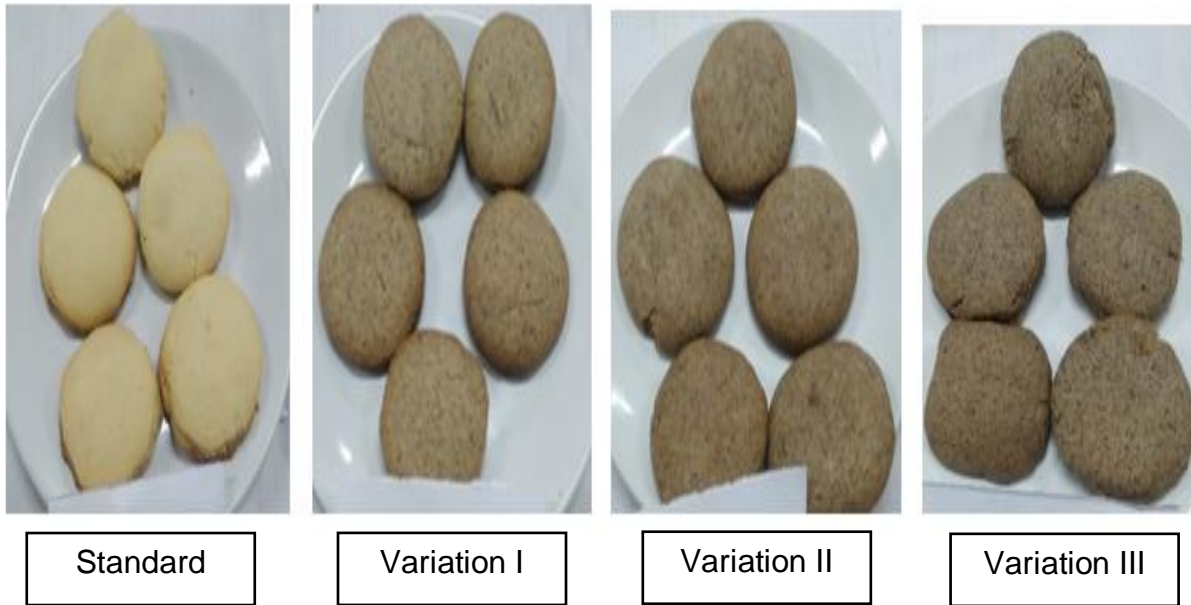
Sensory evaluation Scores of Lotus Root Cookies

	Appearance	Color	Texture	Flavor	Taste	Overall Acceptability
Standard	8.7±0.48	8.5±0.53	8.5±0.53	8.5±0.53	8.8±0.42	8.6±0.27
Variation I	8.7±0.67	8.5±0.53	8.1±0.57	8±0.67	8.3±0.67	8.32±0.32
Variation II	8±1.05	7.4±0.97	7.1±1.37	6.8±0.79	6.2±1.03	7.1±0.81
Variation III	6.4±0.84	6.1±1.37	6.7±0.82	5.6±0.97	5.3±1.16	6.02±0.81

Variation I obtained similar scores for appearance and colour as for standard recipe and the texture, flavor and overall acceptability scores were less for variation I when compared to standard. Among the three, variation II and III got scores lesser than 8 showing that it was not liked much by the panelist. The colour of the cookies was darker in variation III with 20g of lotus root powder and the taste was also slightly bitter.

Variation I with 10g of lotus root powder with a mean overall acceptability score of 8.32 was the most acceptable variation.

The prepared cookie recipes are presented in Plate 6



Sensory Evaluation

Plate 6: Sensory Evaluation of Lotus Root Cookies

The test of significance done for the standard and the most acceptable variation I, it showed that there is a significance difference in the score at 1% level of significance on overall acceptability. The mean acceptability of standard was 8.6 ± 0.27 and that of variation I was 8.32 ± 0.32 .

Texture Analysis of Cookies:

The hardness of the cookies, standard and variation I was analyzed using texture analyzer and the data is presented in table XIX and peak values of standard and variation presented in figure 10 and 11 respectively

Table XIX

Texture Analysis (Hardness) – Cookies

Type	Standard	Variation I
Hardness	13.8005 N	13.7626 N

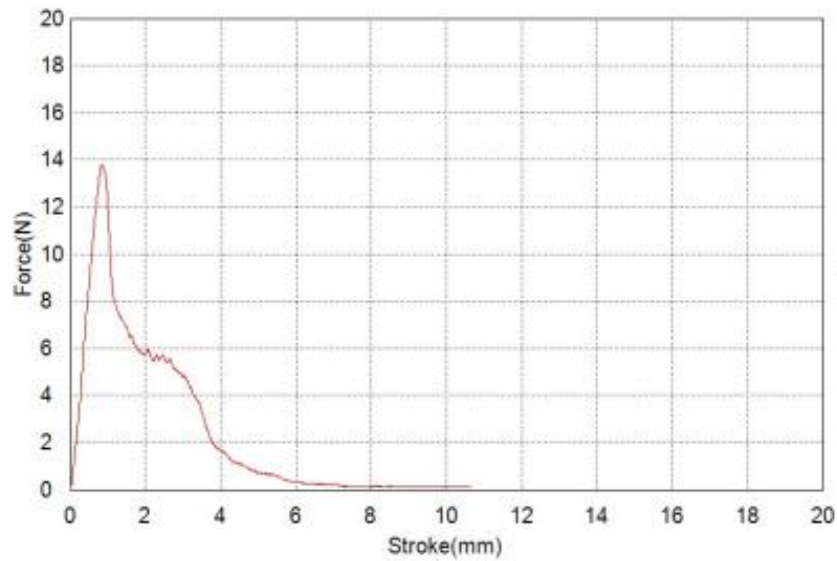


Figure 10: Hardness of Cookies -Standard

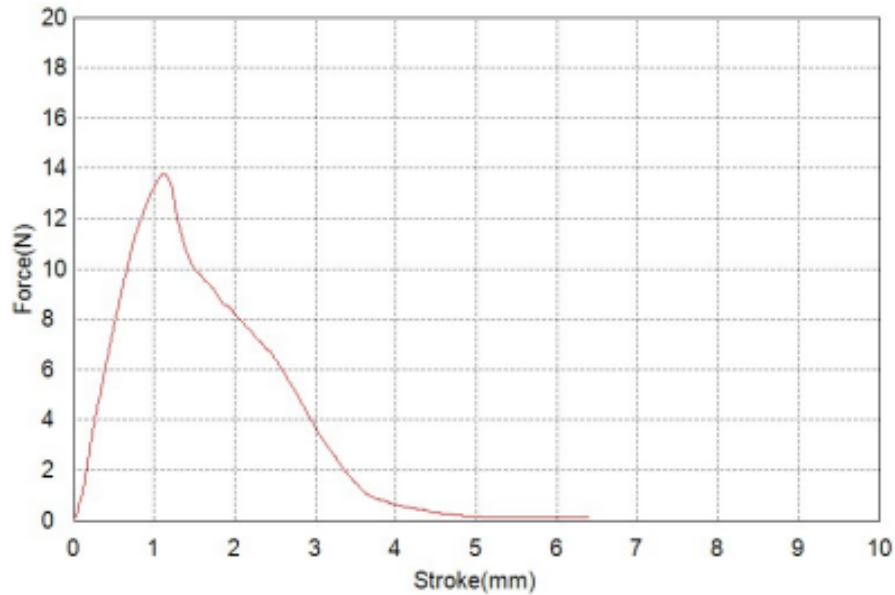


Figure 11: Hardness of Cookies -Variation I

The data shows that incorporation of 10g of lotus root powder did not bring any textural changes as there was no difference in the values obtained for hardness in both standard and variation I which received values of 13.8 N for hardness.

C) Nutritive value of lotus root fresh, lotus root powder and recipes developed:

1. Lotus Root Fresh:

Table XX shows the values for Iron, Calcium Vitamin C analysed in 100g of fresh root. The moisture content of fresh root was 74 percent

Table XX

Iron, Calcium, and vitamin C content of Fresh Lotus Root

Nutrient	Quantity/100g
Iron(mg)	65
Calcium (mg)	220
Vitamin C(mg)	3421

From the table it that 100gram of fresh Lotus root powder contains 65mg of iron, 220mg of calcium and 3421mg of vitamin c. Thus, there is more of Vitamin C in Fresh Lotus Root.

2. Lotus Root Powder

The iron, calcium and vitamin C content in 100 g of lotus root powder is presented in the Table XXI

Table XXI
Iron, Calcium and Vitamin-C Content of Lotus Root Powder

Nutrient	Quantity/100g
Iron(mg)	183
Calcium (mg)	51
Vitamin C(mg)	NIL

Comparing fresh and powdered lotus root, the powder lacked vitamin C which may be lost due to drying. Calcium content was less and iron content was more. From the above Table XXI it can be observed that in 100gm of Lotus root powder 183mg of iron, 51mg of calcium is present and vitamin C is absent.

3. Nutritive value of Lotus Root Pakoda

The calculated values (per serving) for the ingredients used in prepared pakoda is presented in Table XXII

Table XXII
Nutritive Value of Lotus Root Pakoda

Nutrient	Quantity
Energy (kcal)	103
CHO (g)	5.1
Protein (g)	0.9
Fat (g)	2 g
Fibre (g)	1.4
Iron (mg)	0.8
Calcium (mg)	8.1
Vitamin C (mg)	5.2

The nutritive values are shown in the above table XXII, it is shown that in Pakoda Energy level is 103 kcal, Fibre was 1.4 g. Calcium level were 8.1 mg, vitamin C value were 5.2 mg, CHO value were 5.1g, fat content were 2 g, protein level were 0.9 g and iron level were 0.8mg.

The quantity of ingredients taken for calculation is given in the recipe enclosed in Annexure III. The values presented are for one portion size (30 g) of the recipe. The attributes of freshly cut lotus root pakoda had mean scores of eight and above showing that the recipe was liked very much in terms of appearance, texture, flavor, taste and over all acceptability.

In comparing a recipe prepared by deep fry method, Yodkraisri (2012) examined the deep fried chips produced from lotus root rhizome. Effects of three different frying temperatures (180, 190 and 200°C, for 15-20 sec) on the overall qualities (proximate composition, texture and sensory) of lotus rhizome chips were determined. Prior to frying, freshly procured rhizomes were sliced uniformly (thickness of ~2.5 mm, diameter ~ 5.2mm), blanched in hot water (85°C for 3.5 min) and dried in a hot air vacuum oven (60°C, 24 h).

Nutritive value of Lotus Root Pickle

The calculated values (per serving) for the ingredients used in prepared Pickle is presented in Table XXIII. The recipe with quantity of ingredients is given in the Annexure III.

Table XXIII
Nutritive Value of Lotus Root Pickle

Nutrient	Quantity
Energy (kcal)	16
CHO (g)	0.70
Protein (g)	0.14
Fat (g)	1
Fibre (g)	1.45
Iron (mg)	0.17
Calcium (mg)	2.26
Vitamin C (mg)	0.9

Pickle is served in small quantity. The vales presented in the table XXIII was for one serving (5 g) which is approximately one teaspoon of serving size. It was observed that in 5g serving of the prepared Pickle, the energy is 16 kcal, calcium present 2.26mg, vitamin C level is 0.9mg, and fiber content 1.45 g. The carbohydrate content is 0.70 g, fat content 1 g, protein content 0.14 g and iron 0.17 mg. The Pickle is rich in calcium and fibre.

Park (2009) examined the quality characteristics of lotus root pickle added with beet water extract. The hardness of lotus root pickles measured instrumentally was higher in lotus root pickle added with 40% beet water extract than in control pickle. Overall, based on sensory evaluation, lotus root pickle added 30% beet extract was preferred over the other samples. In the current study freshly cut lotus pickle was studied. The sensory evaluation scores of fresh Lotus root for pickle for appearance and colour has mean value of 8.4, texture and taste had 8 and the overall acceptability score was above 8. Hence the recipe received a liked very much score for acceptability.

4. Nutritive value of Peanut chocolate

The nutritive value of peanut chocolate is presented in Table XXIV. The values calculated for Energy, CHO, Protein, Fat, Fibre, Iron, Calcium, Vitamin C are for one portion size (Annexure III)

Table XXIV

Nutritive Value of Peanut Chocolate

Nutrient	Quantity	
	Standard	Variation 1
Energy (kcal)	124	125
CHO (g)	13	13
Protein (g)	1.7	1.7
Fat (g)	1	1
Fibre (g)	7.1	7.1
Iron (mg)	0.61	0.51
Calcium (mg)	4.85	5.37
Vitamin C (mg)	0	0

The above Table XXIV shows the nutritive value of peanut chocolate for one serving (7 g). The energy content was 124 kcal for standard recipe and 125 kcal for variation I and contains 13 g of Carbohydrate in both standard and variation I. Fiber content in standard recipe was 7.1g and variation I, calcium level was 4.8 in standard and 5.37g in Variation I, protein level was 1.7g in standard and variation I. Fat content in standard recipe and variation I were one gram and iron value was 4.88 mg in standard and 5.21 mg in variation I, in both the recipes vitamin C was absent. Thus, the incorporation increased the calcium content of the peanut chocolate.

Nutritive value of Jam

The nutritive value of jam prepared with lotus root (10g) and standard recipe is presented in Table XXV. The values calculated for Energy, CHO, protein, Fat, Fibre, Iron, Calcium and Vitamin C of one portion size (Annexure III)

Table XXV

Nutritive Value of Jam

Nutrient	Quantity	
	Standard	Variation 1
Energy(kcal)	39	39
CHO(g)	9	10
Protein(g)	0.04	0.06
Fat(g)	0.12	0.17
Fiber(g)	0.01	0.02
Iron(mg)	0.01	0.05
Calcium(mg)	1.83	2.21
Vitamin C(mg)	1.27	1.27

The result shows that 39kcal were present in standard recipe and Variation I for one serving (15 g),CHO value were 9 g in standard and 10 g in variation I, calcium level were 1.83g in standard and 2.21mg in variation I, vitamin C were 1.27mg in standard and variation I, fat content were 0.12g in standard recipe and 0.17g in variation I, iron value represents 0.01mg in standard and 0.05mg in variation I, protein level shows that 0.04g of protein were present in

standard recipe whereas 0.06 g of protein presented in variation I and fiber value were 0.01 g in standard and 0.02 g in variation I.

5. Nutritive value of Cookies

The nutritive value of Cookies prepared with lotus root (10g) and standard recipe is presented in Table XXVI. The values calculated for Energy, CHO, protein, Fat, Fibre, Iron, Calcium and Vitamin C of one portion size (Annexure III)

Table XXVI

Nutritive Value of Cookies

Nutrient	Quantity	
	Standard	Variation 1
Energy(kcal)	173	175
CHO(g)	19	19
Protein(g)	2	2
Fiber(g)	0.5	0.6
Fat(g)	10	10
Iron(mg)	0.36	0.42
Calcium(mg)	4.5	5.3
Vitamin C	0	0

Form the above Table XXVI it can be observed that 173 kcal was present in standard recipe of cookies and 175 kcal were seen in variation I for one portion size (20 g per cookie), CHO value were 19g in both standard and variation I, fat content was seen as 10 g in both standard and variation I, calcium value were 4.5 mg in standard and 5.3 mg in variation I, protein level were 2 g in standard and variation I, fiber values as 0.5 g in standard and 0.6 g in variation I and iron level were 0.36 mg in standard and 0.42 mg in variation and vitamin C were absent in both the recipes.

Saeed et.al. (2020) formulated lotus (*Nelumbo nucifera*) as a fat mimetic for the development of functional biscuits. Nutritional data revealed that protein (11.20–13.40%), ash

(0.53–2.86%), and the crude fiber content (0.21–15.60%) of biscuits increased, and calories reduced (497–375kcal/100 gm). Therefore, this study explores the potential of using LRF as a fat mimetic in biscuits with the application on a commercial scale to enhance antioxidant, physical, nutritional, and sensory attributes. In the study cookies were made out of Lotus root.

Shelf-life of Pickle and Jam

Shelf-life of the Pickle.

The shelf life of the pickle was analysed by directly observing the visibility of spoilage as mould formation and for changes in the quality of the pickle in terms of appearance, colour, texture, flavour, taste and overall acceptability. The product was stored in a clean and dry air tight glass container and was stable and had no changes in the sensory attributes up to a period of 30 days. On the 30th day slight moulds formations were found.

A. Shelf-life of the Jam.

The lotus root powder jam was stored at the room temperature in an air tight glass container. Jam attributes such as the appearance, color, texture, flavor, taste, and overall acceptability of the recipe was checked for 30 days. There were no changes in these attributes. The recipe was also tested for presence/ absence of E.coli as presented in Table XXVII

Table XXVII

Test for E.coli in Jam

Day	Presence or absence of E.coli.
1 to 10 days	Absent
10 to 20 days	Absent
20 to 30 days	Absent

As seen in the above Table no E.coli was detected at the end of 30 days. Other visible changes for microbial growth such as or fungus were also observed and no visible changes in the appearance, colour and microbial growth in the jam was during the 30 days of observation.

Shukla (2018) made sugar syrup using lotus root. All the lotus root fermented sugar syrup samples were subjected to microbiological analysis. It was found that the coliform,

Bacillus cereus, Escherichia coli, Salmonella and Staphylococcus aureus counts were not detected in majority of the samples, confirming the high degree of hygiene processing of lotus root fermented sugar syrup samples for its use as a food supplement or condiment.

D) Promotion of recipes developed with Lotus root

The current study promoted the recipe formulated namely cookies, peanut chocolate, jam, pickle and pakoda through social media such as Instagram, YouTube and WhatsApp. Videos and photos are shared for the respondents by using the social media platforms. The respondents were made aware about the consumable parts of the lotus plant (flower, root, leaves, stem, etc.) and health benefits of the plant parts. The respondents were also provided knowledge on cleaning and consuming the lotus root both freshly and as in powder form. A demonstration on the preparation of the recipes developed was also included.

This study thus has explored the possibility and incorporating this novel food in traditional recipes and has also made evident that the incorporation as fresh lotus root enhances the fiber, iron, calcium and vitamin C content of the recipes and incorporation of root powder enhances the iron and calcium content and hence is a very good choice for value addition of recipes in terms of iron and calcium.



PLATE VII

AWARENESS ON LOTUS ROOT PRODUCTS ON SOCIAL MEDIA

SUMMARY AND CONCLUSIONS

V. SUMMARY AND CONCLUSION

The study titled “Evaluation of Acceptability and Nutritive Value of Recipes Incorporated with Lotus Root Powder” was conducted in four phases.

Nutritive value and awareness on lotus plant and parts among the general people was studied in a structured questionnaire.

Fresh Lotus Root were selected. Roots cleaned, dried and powder was also prepared. Recipes namely Pakoda and Pickle were prepared with fresh lotus root and Peanut chocolate, Jam and Cookies were prepared by incorporating lotus root powder in these variations namely 10g, 15g and 20g.

The prepared recipes were subjected to sensory evaluation for acceptability on a 9 point hedonic scale. For sensory attributes like appearance, flavor, color, taste and texture. By the trained panelist of 20 members and the most acceptable variation selected. The content of Iron, Calcium and Vitamin C was analyzed for fresh root and dried lotus root powder. Nutritive values was calculated like Iron, Calcium and Vitamin C for the standard recipes and the most acceptable variation. Awareness was created on social media like YouTube, Instagram and WhatsApp.

The salient finding of the study are as follows:

- The appearance of Lotus root powder was free flowing powder with mud colour where the odour was acceptable and tasted bland.
- The developed root and powder was incorporated in common recipes as Pakoda and Pickle (Root), Peanut chocolate, Jam and Cookies (Powder). Three variations in lotus root powder were prepared from 100 g of lotus root powder as 10g, 15g and 20g.
- Among the three variations variation-I with 10 g incorporation was selected as the most acceptable variation in terms of appearance, colour, flavour, taste and texture based on the scores obtained.
- The sensory evaluation scores of fresh Lotus root recipes for all the attributes had highest mean score showing the recipe was likes very much by the panellist.
- The sensory evaluation scores of Lotus Root Powder recipes for all the attributes variation I had highest mean score showing the recipe was likes very much by the panellist.

- As variation I shows the highest mean, the texture analysis was done for Peanut chocolate and Cookies, it shows the hardness in the variation I have increased and adhesive force was not changed much in Peanut chocolate. In cookie the hardness were not changed after incorporating the 10g of lotus root powder.
- The nutrient content of the powder was analysed using standard procedures. The developed powder was rich in both macro and micronutrients. The nutrient contents for Lotus Root are Iron – 65 mg, Calcium – 220 mg, Vitamin C – 3421 mg and Moisture – 74% and the nutrient content for Lotus Root Powder are Iron – 183 mg, Calcium – 51 mg, Vitamin C was absent.
- Pakoda has 103Kcal of energy, 5.1g of CHO, 0.9g of protein, 8.9g of fat, 1.4g of fibre, 0.8mg of iron, 8.1mg of calcium and 5.2mg of vitamin C.
- Pickle has 16Kcal of energy, 0.70g of CHO, 0.14g of protein, 0.29g of fat, 1.45g of fibre, 0.17mg of iron, 2.26mg of calcium and 0.9mg of vitamin C.
- Peanut chocolate has a 125Kcal of energy, 13g of CHO, 1.7g of protein, 1.1g of fat, 7.1g of fibre, 0.51mg of iron, 5.37mg of calcium and vitamin C were absent. These values are found in variation I which is higher than the standard levels.
- Jam has 39Kcal of energy, 10g of CHO, 0.06g of protein, 0.17g of fat, 0.02g of fibre, 0.05mg of iron, 2.21mg of calcium and 1.27 mg of vitamin C. These values are found in variation I which is higher than the standard levels.
- Cookies has 175Kcal of energy, 19g of CHO, 2g of protein, 0.6g of fat, 0.6g of fibre, 0.42mg of iron, 5.3mg of calcium and vitamin C was absent. These values are found in variation I which is higher than the standard levels.
- Shelf life of the product was also tested. For thirty days the pickle was tested by direct method for sensory attributes and checked for the growth of microorganisms. For thirty days the jam was tested for sensory attributes and checked for the growth of microorganisms and there was no growth of microorganisms observed. The test for E. Coli also revealed the absence of the organism at the end of thirty days.
- The current study promoted the recipe formulated namely cookies, peanut chocolate, jam, pickle and Pakoda through social media such as Instagram, YouTube and WhatsApp.
- The respondents were also provided knowledge on cleaning and consuming the lotus root both freshly and as in powder form. As a part of study we have prepared some

recipes with lotus root and lotus root powder and it were also shared through social media platform

The study demonstrated the easy incorporation of lotus root in recipes like pakoda, chips and pickle which can be stored for longer period and can serve as a substitution for unhealthy snacks and including lotus root powder which is rich in calcium, iron and vitamin C in everyday dish will boost immunity and add value to the recipes. Since it is in a powder form the incorporation is easier and also the preparation will not be affected and the intricacy of preparation is also minimized. So the created lotus root powder will be greatly advantageous to the people.

BIBLIOGRAPHY

VI .BIBLIOGRAPHY

- "Population, total - India | Data". data. worldbank.org. Retrieved 16 September 2021.
- (BASc, J. S., & BFA). (2021, June 25). 9 amazing benefits of lotus root. Retrieved from <https://www.organicfacts.net/health-benefits/vegetable/lotus-root.html>
- 15 health benefits of lotus root, according to science (+4 delicious recipes). (2017, April 26). Retrieved from <https://www.jenreviews.com/lotus-root/>
- A., Sruthi & Thomachan, Seeja & er, Aneena & Pathrose, Berin & Mathew, Deepu. (2019). Insights into the composition of lotus rhizome. 8. 3550-3555.
- Ara T., Nakatani S., Kobata K., Sogawa N., Sogawa C. The Biological Efficacy of Natural Products against Acute and Chronic Inflammatory Diseases in the Oral Region. *Medicines*. 2018; 5 doi: 10.3390/medicines5040122. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
- Arshad, M. S., Khalid, W., Ahmad, R. S., Khan, M. K., Ahmad, M. H., Safdar, S., Kousar, S., Munir, H., Shabbir, U., Zafarullah, M., Nadeem, M., Asghar, Z., & Rasul, H. A. (2021). Functional Foods and Human Health: An Overview. In M. S. Arshad, & M. H. Ahmad (Eds.), *Functional Foods - Phytochemicals and Health Promoting Potential*. IntechOpen. <https://doi.org/10.5772/intechopen.99000>.
- Bae, Hyunsu, Paudel, Keshav Raj, Panth, Nisha, 2015, Phytochemical Profile and Biological Activity of *Nelumbo nucifera*, 89124, 2015.
- Baker, M.T.; Lu, P.; Parrella, J.A.; Leggette, H.R. Consumer Acceptance toward Functional Foods: A Scoping Review. *Int. J. Environ. Res. Public Health* 2022, 19, 1217. <https://doi.org/10.3390/ijerph19031217>
- Beck, K. L., Conlon, C. A., Kruger, R., & Coad, J. (2014). Dietary determinants of and possible solutions to iron deficiency for young women living in industrialized countries: a review. *Nutrients*, 6(9), 3747–3776. <https://doi.org/10.3390/nu6093747>
- Bedi A., Leelavati K., and Prakash V. (2006) Chemical composition and sensory attributes of differently cooked starchy vegetables. *International Journal of Food Science and Nutrition*, 34 (10):334-356.
- Bodyfelt T.L. Deland J.M. Carryquiry A.L. and Johnson L.A. (2005) Principles of sensory evaluation of food. *Indian Journal of Nutrition and Dietetics*. 41:280-286.

- Chaudhary, Ruchi and Pareek, Navita (2010). Enhancement of nutritional quality parameters and acceptability scores of soyblended product enriched with lotus stem powder, *Food Sci. Res. J.*, 1 (2) : 56-59.
- Chen, S & Tengku Mohamad, Tengku Rozaina. (2020). Effect of cooking methods on nutritional composition and antioxidant properties of lotus (*Nelumbo nucifera*) rhizome. *Food Research*. 4. 10.26656/fr.2017.4(4).359.
- Chiang Po-Yuan and Luo Yue-Yu (2007) Effects of pressurized cooking on the relationship between the chemical compositions and texture changes of lotus root (*Nelumbo nucifera* Gaertn.). published in *Food Chemistry*, Vol-105,(2), pp- 480– 484.
- *Chinese Materia Medica*, Jiangsu New Medical College, Peoples Publishing House, Shanghai, China, 1997.
- De Lator E.M., Fernandes A.W.C., de Andrade Teles R.B., Leal A., de Oliveira Junior R.G., Gama E.S.M., de Oliveira A.P., Silva J.C., de Moura Fontes Araujo M.T., Coutinho H.D.M., et al. Essential Oils and Their Major Compounds in the Treatment of Chronic Inflammation: A Review of Antioxidant Potential in Preclinical Studies and Molecular Mechanisms. *Oxid. Med. Cell. Longev.* 2018; 2018:6468593. doi: 10.1155/2018/6468593. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
- Desalegn Wolide A, Mossie A, Gedefaw L (2018) Correction: Nutritional Iron Deficiency Anemia: Magnitude and Its Predictors among School Age Children, Southwest Ethiopia: A Community Based Cross-Sectional Study. *PLOS ONE* 13(8): e0202380. <https://doi.org/10.1371/journal.pone.0202380>
- Du, H., You, J. S., Zhao, X., Park, J. Y., Kim, S. H., & Chang, K. J. (2010). Antiobesity and hypolipidemic effects of lotus leaf hot water extract with taurine supplementation in rats fed a high fat diet. *Journal of biomedical science*, 17(1), 1-5.
- Du, H., Zhao, X., You, J. S., Park, J. Y., Kim, S. H., & Chang, K. J. (2010). Antioxidant and hepatic protective effects of lotus root hot water extract with taurine supplementation in rats fed a high fat diet. *Journal of biomedical science*, 17 Suppl 1(Suppl 1), S39. <https://doi.org/10.1186/1423-0127-17-S1-S39>
- Ellis (2022), <https://www.eatright.org/food/nutrition/healthy-eating/functional-foods>
- Firdous 2020, <https://www.lybrate.com/topic/benefits-of-lotus-root-and-its-side-effects>

- Freigang S. The regulation of inflammation by oxidized phospholipids. *Eur. J. Immunol.* 2016; 46:1818–1825. doi: 10.1002/eji.201545676. [PubMed] [CrossRef] [Google Scholar]
- Freigang, S. (2016). The regulation of inflammation by oxidized phospholipids. *European journal of immunology*, 46(8), 1818-1825.
- Hajela, Soumya & Srivastava, Rachana. (2019). A Review on Health Benefits of Lotus Seeds (*Nelumbo nucifera*). 5. 92-96. Gani Adil , Gazanfar Tahir, Jan Romee , Wani S.M. and Maoodi F.A. (2013) Effect of gamma irradiation on the physicochemical and morphological properties of starch extracted from lotus stem harvested from Dal lake of Jammu and Kashmir, India. *Journal of the Saudi Society of Agricultural Sciences*, Vol-12,(2), pp-109– 115.
- Harinarayan CV, Akhila H and Shanthisree E (2021) Modern India and Dietary Calcium Deficiency—Half a Century Nutrition Data—Retrospect—Introspect and the Road Ahead. *Front. Endocrinol.* 12:583654. doi: 10.3389/fendo.2021.583654
- Harinarayan, C. V., & Akhila, H. (2019). Modern India and the Tale of Twin Nutrient Deficiency-Calcium and Vitamin D-Nutrition Trend Data 50 Years-Retrospect, Introspect, and Prospect. *Frontiers in endocrinology*, 10, 493. <https://doi.org/10.3389/fendo.2019.00493>
- Hidemi, T. L.; Deland J. M.; Carryquiry, A.L. and Johnson, L.A. (2010) Microbiological and physiological quality of fresh cut lotus. *Journal of Chinese cereals oil association*, 17:25-28.
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5785387>
- <https://www.tandfonline.com/doi/full/10.1080/19476337.2020.1812727>
- J. Yu and W. S. Hu, “Effects of neferine on platelet aggregation in rabbits,” *Yaoxue Xuebao*, vol. 32, no. 1, pp. 1–4, 1997. View at: Google Scholar
- Kandlakunta, Bhaskarachry & Vemula, Sudershan & Gavaravarapu, Subbarao & Kumar, Apurva. (2016). *Traditional Foods, Functional Foods and Nutraceuticals*
- Kaneyasu, M., Nagata, M., Ikeda, H., Ohnuki, K., & Shimizu, K. (2019). Anti-allergic activity of lotus root (*Nelumbo nucifera*) powder in TDI-sensitized nasal allergy model mice. *Food and Agricultural Immunology*, 30(1), 968-978. <https://doi.org/10.1080/09540105.2019.1651255>

- Kang,.; Borrelli, F.; and Lzzo, A.A. (2011) Effect of storage on edible value of lotus stem. *Journal of food science and nutrition*,357(23):451-457.
- Karnik, P. (2022, May 24). Lotus root: Health benefits, recipes, side effects, and more. Retrieved from <https://www.stylecraze.com/articles/lotus-root/>
- Kim, Gui-Sun & Park, Geum-Soon. (2008). Quality Characteristics of Cookies Prepared with Lotus Leaf Powder. *Korean journal of food and cookery science*. 24.
- Ku-Lee H., Mun-choi Y., Chung H., Kang C. Paevez S., and Bae H. (2005) Antioxidant effects of korean traditional lotus liquor (Yunyupju). *International Journal of Food Science and Technology*. Vol. 40: pp 709-787.
- la Cour B, Mølgaard P, Yi Z. Traditional Chinese medicine in treatment of hyperlipidaemia. *J Ethnopharmacol*. 1995 May;46(2):125-9. doi: 10.1016/0378-8741(95)01234-5. PMID: 7650951
- Li, X., Guo, Y., Chen, L. et al. Texture and bio-functional characteristics of a Chinese steamed bread prepared from lotus root powder partially replacing wheat flour. *Sci Rep* **11**, 16338 (2021).
- Liberal, Ângela, José Pinela, Ana M. Vívar-Quintana, Isabel C.F.R. Ferreira, and Lillian Barros. 2020. "Fighting Iron-Deficiency Anemia: Innovations in Food Fortificants and Biofortification Strategies" *Foods* 9, no. 12: 1871. <https://doi.org/10.3390/foods9121871>
- Ling, C. Q., Fan, J., Lin, H. S., Shen, F., Xu, Z. Y., Lin, L. Z., ... & Zhou, Q. H. (2018). Clinical practice guidelines for the treatment of primary liver cancer with integrative traditional Chinese and Western medicine. *Journal of integrative medicine*, 16(4), 236-248.
- Longvah, Thingnganing & Ananthan, Rajendran & Bhaskar, K & Venkaiah, K. (2017). *Indian food Composition*
- Lu S., Wu D., Sun G., Geng F., Shen Y., Tan J., Sun X., Luo Y. Gastroprotective effects of Kangfuxin against water-immersion and restraint stress-induced gastric ulcer in rats: Roles of antioxidation, anti-inflammation, and pro-survival. *Pharm. Biol.* 2019;57:770–777. doi: 10.1080/13880209.2019.1682620. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
- Lui, G., and Lee, X. (2010) Effect of processing on flavour of lotus stem powder beverages. *Journal of Food Science and Technology*, 3:16-19.

- M. Ou, *Chinese-English Manual of Common-Used in Traditional Chinese Medicine*, Joint Publishing Company, Hong Kong, 1989.
- Ma, Y., Liu, D., Zhang, W., Li, J., & Wang, H. (2021). Effects of Hot-Air Coupled Microwave on Characteristics and Kinetics Drying of Lotus Root Slices. *ACS omega*, 6(5), 3951-3960.
- Mahdi et.al. (2016), *International Journal of Research in Agricultural Sciences* Volume 3, Issue 5,2016.
- Muhammad Aslam Shad, Nawaz, Haq, Hussain Mazhar And Yousuf Beena (2011) Proximate Composition And Functional Properties of Rhizomes of Lotus (*Nelumbo Nucifera*) Department of Chemistry, Bahauddin Zakariya University, Multan-60800, Pakistan. *Pakistan Journal Botany.*, 43(2): 895-904.
- Muhammad, Syed & Saeed, Ghufraan & Tayyaba, Sidra & Syed, Arsalan & Ali, Sania & Tayyab, & Syed, Asad & Sayeed, Rashida & Ali, Lubna & Mobin, Shahina & Naz, & Ali, & Tayyab, Sania & Sayeed, & Ali, Rashida & Mobin, Lubna & Naz, Shahina. (2020). *CyTA -Journal of Food* ISSN: (Print) (Evaluation of the potential of Lotus root (*Nelumbo nucifera*) flour as a fat mimetic in biscuits with improved functional and nutritional properties Evaluation of the potential of Lotus root (*Nelumbo nucifera*) flour as a fat mimetic in biscuits with improved functional and nutritional properties. *CyTA - Journal of Food*. 18. 624-634. 10.1080/19476337.2020.1812727.
- Mukherjee, P. K., Mukherjee, D., Maji, A. K., Rai, S., & Heinrich, M. (2009). The sacred lotus (*Nelumbo nucifera*)–phytochemical and therapeutic profile. *Journal of Pharmacy and Pharmacology*, 61(4), 407-422.
- *Omega* **2021** 6 (5), 3951-3960, DOI: 10.1021/acsomega.0c05824
- Onishi, K. Yamada, T. Yamada et al., “Comparative effects of crude drugs on serum lipids,” *Chemical & Pharmaceutical Bulletin*, vol. 32, no. 2, pp. 646–650, 1984. View at: [Publisher Site](#) | [Google Scholar](#)
- Park Yong-Seo, Towantakavanit Korsak, Kowalska Teresa, Jung Soon-Teck, Ham Kyung-Sik, Heo Buk-Gu, Cho Ja-Yong, Yun Jae-Gill, Kim Hyun-Ju, and Gorinstein Shela. (2007) Bioactive Compounds and Antioxidant and Antiproliferative Activities of Korean White Lotus Cultivars Departments of Horticultural Science Mokpo National University, Muan, *Journal of Medicinal Food* 12 (5):1057–1064.

- Park, Bock-Hee & Jeon, Eun-Raye & Kim, Sung-Doo & Cho, Hee-Sook. (2010). Quality Characteristics of Dried Noodle Added with Lotus Leaf Powder. *Journal of the Korean Society of Food Culture*. 25.
- Park, Bock-Hee & Jeon, Eun-Raye & Kim, Sung-Doo & Cho, Hee-Sook. (2009). Changes in the Quality Characteristics of Lotus Root Pickle with Beet Extract during Storage. *Journal of The Korean Society of Food Science and Nutrition*. 38. 1124-1129. 10.3746/jkfn.2009.38.8.1124.
- Prentice, A. M., Mendoza, Y. A., Pereira, D., Cerami, C., Wegmuller, R., Constable, A., & Spieldenner, J. (2017). Dietary strategies for improving iron status: balancing safety and efficacy. *Nutrition reviews*, 75(1), 49–60. <https://doi.org/10.1093/nutrit/nuw055>
- R. N. Chopra, S. L. Nayar, and I. C. Chopra, *Glossary of Indian Medicinal Plants*, Council of Scientific Industrial Research, New Delhi, India, 1956.
- Rana (2018), <https://food.ndtv.com/food-drinks/6-lotus-root-kamal-kakdi-benefits-from-weight-loss-to-reducing-stress-and-more-1755346#:~:text=Regulates%20Blood%20Pressure,and%20rigidity%2C%20increasing%20blood%20circulation>.
- Ref-Park, Bock-Hee & Cho, Hee-Sook. (2009). Quality Characteristics of Jook Prepared with Lotus Root Powder. *Journal of the Korean Home Economics Association*. 47
- Ross AC, Manson JE, Abrams SA, Aloia JF, Brannon PM, Clinton SK, Durazo-Arvizu RA, Gallagher JC, Gallo RL, Jones G, Kovacs CS, Mayne ST, Rosen CJ, Shapses SA *J Clin Endocrinol Metab*. 2011 Jan; 96(1):53-8.
- Roy (2021) <https://food.ndtv.com/food-drinks/6-lotus-root-kamal-kakdi-benefits-from-weight-loss-to-reducing-stress-and-more-1755346#>.
- Ruchi, C., & Navita, P. (2010). Enhancement of nutritional quality parameters and acceptability scores of soy blended product enriched with lotus stem powder. *Food Science Research Journal*, 1(2), 56-59.
- Saeed, S. M. G., Ayesha, R., Ali, S. A., Ali, R., & Ahmed, R. (2021). Lotus root (*Nelumbo nucifera* Gaertn) flour a novel ingredient for the formulation of traditional unleavened flatbread: Rheological, physical and nutritional characteristics, and sensory attributes. *Journal of Food Processing and Preservation*, 45, e16078. <https://doi.org/10.1111/jfpp.16078>

- Sagara Takefumi, Nishibori Naoyoshi, Sawaguchi, Manami Hiroi, Itoh Takara Mari, Her Song, Morita Kyoji (2012) Lotus root (*Nelumbo nucifera* rhizome) extract causes protective effect against iron-induced toxic damage to C6 glioma cells. Laboratory of Cell Biology and Toxicology, Department of Food Science and Nutrition, Shikoku Junior College, Ohjin, Tokushima, Japan. Vol. 2(2): 179-189.
- Shad Muhammad Aslam , Haq Nawaz, Hussain Mazhar and Beena Yusuf (2010) Proximate composition and functional properties of rhizomes of lotus (*Nelumbo nucifera*) from punjab, Pakistan Journal of Biotechnology, 43(2):895-904.
- Shen-Miller, J., Mudgett, M. B., Schopf, J. W., Clarke, S., & Berger, R. (1995). Exceptional seed longevity and robust growth: ancient sacred lotus from China. *American Journal of Botany*, 82(11), 1367-1380.
- Shukla S, Park J, Park JH, Lee JS, Kim M. Development of lotus root fermented sugar syrup as a functional food supplement/condiment and evaluation of its physicochemical, nutritional and microbiological properties. *Journal of Food Science and Technology*. 2018 Feb;55(2):619-629. DOI: 10.1007/s13197-017-2971-3. PMID: 29391626; PMCID: PMC5785387.
- Singthong, J.; Meesit, U. Characteristic and functional properties of Thai lotus seed (*Nelumbo nucifera*) flours., *International Food Research Journal* . 2017, 24 (4), 1414-1421.
- Sridhar K.R. and Bhat, R. (2007). Lotus – A potential nutraceutical source. *Journal of Agricultural Technology* 3(1): 143-155.
- Tania G Sánchez-Pimienta, Nancy López-Olmedo, Sonia Rodríguez-Ramírez, Armando García-Guerra, Juan A Rivera, Alicia L Carriquiry, Salvador Villalpando, High Prevalence of Inadequate Calcium and Iron Intakes by Mexican Population Groups as Assessed by 24-Hour Recalls, *The Journal of Nutrition*, Volume 146, Issue 9, September 2016, Pages 1874S–1880
- Tarun Gera, Harshpal Singh Sachdev, Erick Boy, Effect of iron-fortified foods on hematologic and biological outcomes: systematic review of randomized controlled trials, *The American Journal of Clinical Nutrition*, Volume 96, Issue 2, August 2012, Pages 309–324, <https://doi.org/10.3945/ajcn.111.031500>
- *The Pharma Innovation Journal* 2019; 8(5): 81-85
- Tighe-Neira, R., Alberdi, M., Arce-Johnson, P., L.Romero-Romero, J., Reyes-Díaz, M., & Inostroza-Blancheteau, C. (2017). Foods with Functional Properties and their

Potential Uses in Human Health. In V. Waisundara, & N. Shiomi (Eds.), *Superfood and Functional Food - An Overview of Their Processing and Utilization*. IntechOpen. <https://doi.org/10.5772/67077>

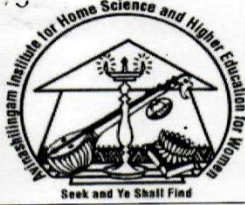
- Vora and Srinivasan , *IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)* e-ISSN: 2319-2402,p- ISSN: 2319-2399.Volume 10, Issue 5 Ver. I (May. 2016), PP 37-43
- Wasagu, RSU & Lawal, M & Galadima, LG & Aliero, A. A.. (2015). Nutritional composition, antinutritional factors and elemental analysis of *Nymphaea lotus* (water lily). *Bayero Journal of Pure and Applied Sciences*. 8. 1. 10.4314/bajopas.v8i1.1.
- Xiong, C., Zhang, Y., Xu, X., Lu, Y., Ouyang, B., Ye, Z. & Li, H. 2013 Lotus roots accumulate heavy metals independently from soil in main production regions of China *Scientia Hort*. 164 295 302
- Yodkraisri, W. & Bhat, Rajeev. (2012). Quality evaluation of deep fried chips produced from lotus rhizome. *International Food Research Journal*. 19. 1423-1427.
- Yongcai Ma, Dan Liu, Wei Zhang, Jun Li, and Hanyang Wang *ACS*
- Yoon, Sook-Ja & Noh, Kwang-Seok. (2009). The Effect of Lotus Leaf Powder on the Quality of Dasik. *Korean journal of food and cookery science*. 25.
- Zaidi, Aamena & Shamim, Zaki & Dixit, Anamika. (2021). formulation and organoleptic evaluation of lotus stem fortified cookies. 10. 1310-1314. 10.17605/osf.io/kngsq.
- Zaidi, Aamena & Shamim, Zaki. (2020). formulation and nutritional analysis of lotus stem incorporated cookies. 10.13140/rg.2.2.16642.71360.

ANNEXURES

Annexure I

Ethical Clearance

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

26th Februaury 2022

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. Sudamani Ramasamy
Dr. G. Victoria Naomi
Dr. Judith Justin
Dr. Anitha Subash

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


Dear Sandhiya S,

Ref: Your proposal No. IHEC/21-22/FSMD-24 entitled
“Evaluation of Acceptability and Nutritive Value of Recipes
Incorporated with Lotus Root Powder” submitted for approval of
IHEC on 23.11.2021.

The Institutional Human Ethics Committee of our University
hereby grants approval to your research proposal No. IHEC/21-22/
FSMD-24 entitled “Evaluation of Acceptability and Nutritive Value
of Recipes Incorporated with Lotus Root Powder” submitted by you.
The Approval number for the same is AUW/IHEC/FSMD-21-
22/XPD-24.

We wish you all the best in your research endeavours.

Regards,


Dr. S. Uma Mageshwari
Member Secretary



Annexure II
Plagiarism Report

INTRODUCTION

by Sandhiya S

Submission date: 31-May-2022 10:33AM (UTC+0530)
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INTRODUCTION

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Annexure - III

Questionnaire

Socio-Demographic profile of the respondents

1. Age:
 - a. 18 – 25 years
 - b. 25-40 years
 - c. 40-60 years
 - d. 60 years and above
2. Gender :
 - a. Male
 - b. Female
3. Marital Status :
4. Married b. Widow c. Divorced
5. Family Type:
 - a. Nuclear
 - b. Joint
 - c. Extended
6. Family Size:
 - a. 2-4
 - b. 4-6
 - c. Above 6
7. Education:
 - a. Illiterate
 - b. High School
 - c. Graduate
 - d. Post Graduate
8. Occupation
 - a. Private Sector
 - b. Public Sector
 - c. Self Employed
 - d. Homemaker
 - e. Unemployed
9. Monthly Income:
 - a. Below 20,000
 - b. 20,000-30,000
 - c. 30,000-4,0000
 - d. Above 40,000

General Dietary Incorporation and Awareness on Lotus Plant on Food

10. What is your eating Habit?
 - a. Vegetarian
 - b. Non Vegetarian
 - c. Ovo -Vegetarian
11. Are you giving any healthy supplement for your family members?
 - a. Yes
 - b. NoIf yes specify _____
12. Are you or your family members consuming any kind of herbal products?
 - a. Yes
 - b. NoIf yes specify _____
13. Are you aware of traditional plant foods with health benefits _____
14. Do you consume any uncommon foods in your daily diet? Yes No
If Yes, What is the motivational factor behind preferring these uncommon foods?

- a. Nutritional facts b. Taste c. Cost
 d. Easy Availability e. Any Others

15. Are you aware of the edibility of lotus plant, lotus root, stem, seeds, etc?

- a. Yes b. No

If yes, mention _____

16. In which form you can consume them?

- a. Raw b. Cooked c. Half Cooked

17. Specifically lotus roots are available in the market?

18. Any particular pre-preparations needed for cooking them and have you prepared any recipe from lotus root, if yes, mention the names?

- a. Yes b. No

If yes, why?

19. Are you aware about the nutritional aspect of lotus root powder?

- a. Yes b. No

If yes, from where do you come to know about lotus roots powder as consumable?

20. Any particular reasons for preferring / avoiding lotus root as food?

Reasons for preference	✓	Reasons for avoidance	✓
Nutritional facts		Unfamiliar	
Taste		Allergy	
Cost		Cost	
Easy availability		Unavailability	
Social Media influence		Physiological state	
Any other		Any other	

21. Are you ready to incorporate lotus root in your diet if they are available in convenient form?

- a. Yes b. No

If yes, mention the form of consumption _____

Annexure IV

Standardized Recipes

PAKODA

No. of. Serving: 6

Cooking Time: 30 Minutes

Cooking Method: Deep Frying

Total yield: 128 g

Ingredients	Quantity	Quantity Per Serving
Lotus Root	100 g	17 g
Corn Starch	5 g	1 g
Gram Flour	10 g	2 g
Green Chili Paste	5 g	1 g
Ginger Garlic Paste	5 g	1 g
Red Chili Powder	5 g	1 g
Turmeric Powder	2 g	1 g
Salt	3 g	0.5 g
Refined Oil	50 ml	10 ml

Method: Cleaned and sliced lotus root into thin even slices. Blanched it and completely dried it then mixed all dry and wet ingredients together deep fried it immediately till it get slight brown color then Pakoda was ready to serve. Stored it in an air tight container.

PICKLE

No.of.Serving : 30

Cooking Time: 25 Minutes

Total yield: 154 g

Ingredients	Quantity	Quantity Per Serving
Lotus Root	100 g	3 g
Mustard	4 g	0.1 g
Fenugreek Seeds	2 g	0.06 g
Fennel Seeds	2 g	0.06 g
Chili Powder	4 g	0.12 g
Turmeric Powder	2 g	0.06 g
Vinegar	3 ml	0.1 ml
Oil	40 ml	1 ml
Salt	2 g	0.06 g

Method: Washed and cleaned lotus root. Sliced them into thin small piece and blanched completely drained water and dry by using clean white cloth in a pan dry roasted mustard seeds, fenugreek seed, and fennel seeds and grained it into a fine powder. Then in a clean and dry pan added 30ml of oil and fried lotus root into fine golden brown. In that same pan added 10 ml of oil and added chili powder, turmeric powder, salt, and already grained powder and cooked for 5 minutes in a low flam. Then added vinegar, this has made a slight brightness in a mix, then added fried lotus root and cooked for 10 minutes at low flame. Finally lotus root pickle was ready to serve.

PEANUT CHOCOLATE

No. of. Serving: 8

Cooking Time: 20 Minutes

Total yield: 115 g

Ingredients	Quantity	Quantity Per Serving
Peanut	40g	5 g
Sugar	80g	10 g
Butter	10g	1.25 g
Whipping Cream	40g	5 g
Dark Chocolate	40g	5 g
Refined Oil	2ml	0.25 ml
Salt	1pinch	0
Lotus Root Powder	0	0

Method: In a clean and dry pan added peanuts and roasted it well and removed skin. Then chopped it into small pieces also made sugar syrup and brought it into a soft ball consistency. Then added all other ingredients like butter, whipping cream, and salt and lotus root powder and cooked for 2minutes. Switched off the flame and added all peanuts. Immediately added this mixture in a silicon mold and refrigerated it for 20 minutes. Meanwhile double boiled dark chocolates with adding little refined oil. Then demolded the peanut mix and dipped it in a dark chocolate and refrigerated it for 5 minutes. Then lotus root peanut bar was ready to eat.

MIXED FRUIT JAM

No. of. Serving: 10

Cooking Time: 15 Minutes

Total yield: 150 g

Ingredients	Quantity	Quantity Per Serving
Pomegranate	10g	1 g
Orange	10g	1 g
Papaya	10g	1 g
Apple	10g	1 g
Green Grapes	10g	1 g
Black Grapes	10g	1 g
Sugar	90g	1 g
Lemon Juice	2ml	1 drop
Lotus Root Powder	0	0

Method: Washed and cleaned all fruits and taken only edible portions. Made it into a fine puree without adding water. Then in a clean and dry pan added mixed fruit puree and stirred continuously for 2min. Then added sugar and mixed till sugar dissolve completely. At this stage offed the flame and added two drops of lemon juice. And left it to attain room temperature. Then stored it in an air tight container Same procedure was followed for three variations but added lotus root powder with various quantity of v1- 10g,v2-15g,v3-20g and cooked 2 min. then switch offed the flame and added lemon juice.

COOKIES

No. of. Serving: 5

Cooking Time: 45 Minutes

Cooking Method: Baking

Total yield: 190 g

Ingredients	Quantity	Quantity Per Serving
All-purpose Flour	100g	20 g
Butter	60g	12 g
Sugar	20g	4 g
Vanilla Essence	2ml	0.5 ml
Lotus Root Powder	0	0

Method: In a bowl added butter and powdered sugar and blended till it get smooth creamy texture. Then sieved all-purpose flour and mixed into that previous mix and made it into a dough Finally added vanilla essence and kneaded very minimum time and left it for resting 2 to 3 mins Preheated oven for 10minutes and then sheeted the dough and cutted into round shape, and baked it for 15 minutes. For variation of cookies same procedure is followed by incorporating lotus root powder in different ratios 10g, 15g and 20g