DEVELOPMENT OF HEALTHY VEGETABLE CANDY SHEETS FOR UNDERWEIGHT CHILDREN

By

LAVANIYA K

(20PFD016)

Thesis submitted to

Avinashilingam Institute for Home Science andHigher Education forWomen

Coimbatore – 641043

In partial Fulfillment of the Requirements for the

Degree ofMaster of Science in

FOOD SERVICE MANAGEMENT AND DIETETICS

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Signature of the Supervisor

Signature of the Head of the Department

CERTIFICATE

This is to certify that the thesis entitled, **"Development of Healthy Vegetable Candy Sheets for Underweight Children"** submitted to Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore in Partial fulfilment of the requirements for the award of the degree of Master of Science in Food Service Management and Dietetics, is a record of original research work done by **Ms. K. Lavaniya** with Register Number 20PFD016 during the period of this study under the Supervision and Guidance of **Dr. S. Thilagamani**, Assistant Professor (SG), Department of Food Service Management and Dietetics, Avinashilingam Institute For Home Science and Higher Education For Women, Coimbatore- 641 043, Tamil Nadu, India.

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ACKNOWLEDGEMENT

First and foremost, the investigator would like to thank God Almighty for his shower of blessings which helped in the successful completion of this project.

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, **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 **Dr.T.S.K. Meenakshi Sundaram**, Managing Trustee, Avinashilingam Institute for Home science and Higher Education for Women, Coimbatore, for providing an opportunity to conduct the study.

The investigator owes a revertial gratitude to Former Chancellor, **Dr.P.R.Krishna Kumar** for his motivation to students and seeks heavenly blessings.The investigator expresses her gratitude to **Dr**. **Prof. S.P.Thyagarajan,** Chancellor, Avinashilingam Institute for Home science and Higher Education for Women, Coimbatore, for providing an opportunity to conduct the study.

The investigator owes her special thanks and gratitude to **Dr.Premavathy Vijayan**, Former Vice Chancellor, Avinashilingam Institute for Home science and Higher Education for Women, Coimbatore, for inspiring 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 to complete the study.

The investigator records her gratitude to **Dr.S.Kowsalya**, Registrar, Avinashilingam Institute for Home science and Higher Education for Women, Coimbatore, for adequate help rendered and infrastructures needed to carry out the work.

The investigator records her heartfelt thanks to **Dr. N. Vasugi**, Dean, school of Home Science, Avinashilingam Institute for Home science and Higher Education for Women, Coimbatore, for her moral support to carry out this thesis.

The investigator owes her heartfelt thanks and gratitude to **Dr.S. Uma Mageshwari**, Dean students affair 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, support rendered for the conduct of the study.The investigator owes her heartfelt thanks and gratitude to **Dr.V.Premala Priyadharsini**, 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, support rendered for the conduct of the study.

The investigator expresses her deep sense of gratitude and whole hearted thanks to her supervisor **Dr. S. Thilagamani**, Assistant Professor (SG), Department of Food Service Management and Dietetics, Avinashilingam Institute for Home science and Higher Education for Women, Coimbatore, her keen interest, constant motivation, support and care rendered from the initial to the final level of the study, which enabled the investigator to complete her project successfully.

The investigator also thank the participants for their kind cooperation and help they rendered for the success of the study.

The investigator expresses her heartfelt thanks to her Parents and friends for their motivation, support, concern and care for the successful completion the study.

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I. INTRODUCTION

The most crucial and a challenging period in human life cycle is the preschool stage. Growth and development of the children is rapid and the early stages of childhood influence the later stages of childhood. Eating habits, food preferences and activity behaviors are characterized in the early childhood. These characteristics influence the effects on the later stages of childhood and carried to adulthood. ***(Santiago et al., 2021)***

Fruits and vegetable consumption help in the prevention of all forms of Malnutrition such as Undernutrition, Micronutrient deficiency, Overweight and Obesity. Further this will also reduce the risk of Non-Communicable Diseases (NCDs). Globally top ten risk factors of diseases were due to Malnutrition and Unhealthy diets. ***(FAO, 2020)***

In early childhood, solid foods are introduced from five months of age. Solid food implementation in children does not have any influence on the type of diet the family followed. To promote the healthy eating habits in children different foods had introduced. ***(Kostecka and Jarecka, 2021)***

Many transitions in India help to achieve the title from developing nation to the developed nation. Both positive and negative aspects of the transitions had been faced by us. Among these, the transition in food over a past 30 years (1973 - 2004) in India has resulted that there was seven per cent decrease in the energy which were derived from carbohydrates and there was a six per cent increase in the energy which were derived from fats. ***(Bhatia and Parida, 2020)***

Malnutrition may occur due to unstable optimal consumption and utilization of essential nutrients which are essential for various physiological actions that occur in the body. Protein-energy malnutrition (PEM) holds various pathological issues due to the inadequate of energy and protein dense diets. The alteration in the metabolism of protein and essential amino acids may affect the circulating plasma protein and albumin in the human body. These plasma protein and albumin were the proteins responsible for the human body to fight against the infections contribute to cause diseases. ***(Javed et al., 2021)***

Children's eating and exercise behaviours were influenced by intrinsic elements such as genetics, age, and gender, as well as environmental influences such as family, peers, neighbour hood, and society. The two characteristics that are linked to parental understanding of healthy eating practices in children are socioeconomic position and educational level. ***(Santiago and colleagues, 2021)***

The massive cause of mortality in children is because of malnutrition, which has been appeared at about half of the total cases. In every single year about six million children are dying because of hunger. Also improper breastfeeding add about one million of deaths in children. Additionally intrauterine growth restrictions, underweight births and other deficiencies of zinc and vitamin- A also increase the death rates of children in the world. Further, malnutrition occur in the first two years of age are not replaceable. These deaths of children have an effect on the growth of every single aspects of the country. Children are the wealth of the country, which are all the treasure for the next generation. The growth of the children will influence the growth of the country. ***(Awuchi et al., 2020)***

During breastfeeding and complementary feeding the essential nutrients needed for children growth and development were very important to meet the nutritional requirement. ***(Kostecka and Kostecka-Jarecka, 2021)***

The Feeding Newborns and Toddlers Studies (FITS) was the largest study in the United States to assess the nutritional intake of infants and young children during a developmentally crucial stage of growth and development, according to ***Anater et al., 2018***.

According to the Feeding Infants and Toddlers Studies (FITS) done in 2008, the food quality of preschool aged children was poorer than that of infants and toddlers. In addition, around 2016, the Feeding Infants and Toddlers Studies (FITS) looked into contemporary difficulties in children such as early childhood nutrition, which can contribute to underweight, incorrect nutritional utilisation, and obesity. ***(Anater et al., 2018)***

Ministry of Statistics and Programme Implementation were carried out a National sample survey (2011-2012) among 1000 households were reporting that consumption of ghee, butter, ice-creams, cold beverages, prepared sweets, baked

products and confectioneries, snack items like chips, processed foods, high sugar concentration foods like jam, jelly, candies, marmalades and high salt concentration foods like pickles, papad, vadagam and other packaged foods were higher in Urban areas while compared with the Rural areas.

Migration of people from Rural to Urban places resulted that there was a both positive and negative changes in the dietary intakes. The positive dietary changes were increased consumption of fruits and vegetables and the negative dietary changes were increased consumption of higher energy and fat foods. ***(Bhatia and Parida, 2020)***

According to the 2015 food database, the mean consumption of fruits were158grams per day and the mean consumption of vegetables were106grams per day in India had revealed (***Dhandevi and Rajesh, 2015).*** Worldwide 402 vegetable crops were cultivated which was resulting from the world Vegetable Survey and highlighted in the **(*Dias, 2012)*** study.

Diet, according to ***Katte et al., (2017),*** was used to determine the health and nutritional state of the population. Protective foods were defined as fruits and vegetables. Vitamins, minerals, antioxidants, phytochemicals, and fibre are abundant in these protective foods, all of which contribute to a higher quality of life. Traditional dietary habits comprised a balanced per centage of all five food categories to promote health by giving healthful and nutritious advantages. Traditional eating traditions have been lost in the intake of food as time has passed.

There were two factors responsible for the change in dietary pattern was lacking of knowledge in nutrition and Urbanization. On account of these two factors the consumption of fruits and vegetables reduced and the consumption of energy dense foods were increased. This transition in Nutrition had lead to malnutrition and expressed the significant impacts on the health of the children. ***(Katte et al., 2017)***

Eighty per cent of the world's malnourished children reside in around 20 nations. Nearly 60 million children in India are underweight. According to the 2019 study, India is placed 102nd out of 119 countries ***(Murakar et al., 2020).***

According to ***Dhandevi and Rajesh, (2015),*** a study found that children under the age of two have a different eating pattern when it comes to fruits and vegetables. Children who ate two or more servings of fruits per day had a 75 per cent rise, while children who ate three or more servings per day saw a 50 per cent increase.

Intake of vegetables in daily diet had exhibited overall good health status, improvements in Gastro Intestinal Health, Vision Efficiency, reduced the risk of specific Cancers, Cardio Vascular Disease, Stroke, Anaemia, Diabetes, Blood Pressure and Gastric Ulcer. ***(Dias, 2012)***

A study conducted in Pune city had revealed that one quarter of the world population composed of School-going children. From this one quarter about three quarters of children were lived in developing countries. In this study, the food habits, frequency of different food items eaten and likes / dislikes of children towards different food items were collected through a qualitative survey by oral questionnaire method. The study resulted that the children around 50 per cent were consumed non-vegetarian foods and children around six per cent were consumed Vegetarian foods. Everyday around 70 per cent of children consumed milk and which had also considered as a least preferred food. A least amount of about five per cent children were consumed Green Leafy Vegetables daily. Most of the children consumed fruits more than two to six times. This study also concluded that the most preferred food among children were snacks, fast food and processed food. ***(Mukherjee and Chaturvedi, 2017)***

Recently more research had been concentrated on the role of Antioxidants which imparts color to the fruits and vegetables. These antioxidants also act as scavengers which were cleaning the free radicals that presented in the body. Fibres presented in the fruits and vegetables had reduced the intestinal passage rates. These fibres were also contributed to the gradual nutrient absorption in the body. High fibre consumption by the intake of fruits and vegetables were attributing to play an important role in calcium absorption. Hence reduce the acid load of the diet. The consumption of fruits and vegetabes were higher in decreasing the risk of congnitive decline and further proved that increased consumption was also essential for mental health. ***(Dhandevi and Rajesh, 2015)***

World Health Organization (WHO) established the guidelines for vegetable consumption of 400 grams per day promoted the health status and also meet the lacking nutrients which were obtaining from the other food groups**.** Vegetables were act as abundant sources of nutraceuticals in the process of achieving a well balanced diet. In many parts of the world vegetables were prescribing as a vital food groups needed to be included in the human diet. Globally, 200 countries were cultivating vegetables to meet these adequate requirements. ***(Ramya, 2019)***

Generally fruits and vegetables are considered as a perishable commodity. Vegetables harvested at a horticulture maturity stage. Prematurely harvested commodities showed a shorter shelf life and poor quality of the commodity. The three main goals of postharvest horticulture were longer shelf life, quality maintenance and reduction of undesirable changes in the vegetables and fruits. The postharvest handling process preserved the quality of vegetables and fruits. Hence, the development of the Vegetable Candy Sheet processing must include effective post harvest handling process.***(Pokhrel, 2021)***

Fruit and vegetable consumption is essential for children's growth and development. It will boost a kid's health; the immune system will be strengthened and the youngster will be protected from infections. A daily intake of seven to eight servings of fruits and vegetables was found to lower the incidence of sadness and anxiety. People who ate fruits and vegetables lived longer, according to a comprehensive research undertaken in ten European nations. Protein was found in less than one per cent of the fresh bulk of most fruit and vegetable tissues. More non-nitrogenous substances, such as free amino acids, chlorophylls, polyamines, and alkaloids, were found in fruits and vegetables ***(Vincente et al., 2014)***.

India was ranked second in the world for horticulture and vegetable crop output, while China was top. From 2004 to 2018, the pace of vegetable output increased from 101 million tonnes to 184 million tonnes. ***(Kumar et al., 2020)***

Since 18th Century, People in search of physical and spiritual health they were attracting more on Vegetarian diets. Roots and tubers were very good sources of energy in the form of starch. The energy utilized from roots and tubers stored for a longer period of time. ***(Slavin and Lloyd, 2012)***

Around an annual carrot production of 1379 thousand MT, India has an area under carrot cultivation of roughly 88,000 hectares, with Haryana accounting for 27.08 per cent, followed by Uttar Pradesh, Punjab, and Tamil Nadu. Carrots are low in calories but high in phytochemicals including carotenoids, anthocyanins, and other phenolic compounds, which provide nutrients. Carrots are high in vitamin A and vegan carotenoids, including Alpha and Beta carotene. It's also known for its sweetness, anti-anemic, healing, diuretic, and calming effects ***(Shafiq.Md et al., 2018)***.

The preparation of Carrot affects the Carotene availability in food. Pureed Carrot showed better absorption than shredded or whole carrots. The absorption of Carotene was more effective when the diet includes at least 15 per cent of fat ***(Vincente et al., 2014).*** Carrot exhibited a rare combination of three flavonoids as Kaempferol, Quercetine and Luteolin. Pumpkin was rich in vitamin C, Carotenoids and Tocopherols. ***(Dias, 2012)***

Carotenoid-rich vegetables boost oxidation resistance in low-density lipoproteins, decreasing DNA damage and generating greater repair activity in humans. Carotenoids help protect the body from free radical damage, lowering the risk of cataracts, heart disease, eye disease, and several malignancies ***(Ramya, 2019)***. Vitamin A deficiency affects around one-third of children under the age of five across the world. Children were blinded and sometimes died as a result of this Vitamin A deficiency. Carrots, pumpkins, and squashes are examples of vegetables that contain important carotene. There are around 600 distinct carotenoids that have been discovered. Beta-Carotene was one of the Carotenoid compounds found in abundance in carrots ***(Vincente et al., 2021)***.

Beetroot is high in iron and folic acid, which not only stimulate red blood cell synthesis but also raise the level of haemoglobin, which improves the oxygenation of the cells overall ***(Maheswari et al., 2013)***. Beetroot is a high source of nitrate and has the ability to lower blood pressure in humans ***(Fatma et al., 2017)***.

Pumpkin is abundant in carotenoids, particularly beta-carotene and lutein, and is a good source of vitamin A. Many nations, including China, Yugoslavia, Argentina, India, Mexico, Brazil, and America, have long utilised it as medicine. It

is widely used in numerous countries to treat worms and parasites as well as to manage diabetes. Pumpkin consumption has also been linked to antihypertensive, immune-modulating, anti-hypercholesterolemia, anti-tumor, anti-inflammatory, and anti-antalgic effects. Pumpkin's vitamin C and carotene levels may be preserved by turning it into candy. Candy manufacture not only extends the shelf life of vegetables, but it also preserves their antioxidant properties ***(Muzzaffar et al., 2016).***

An almond is the king of nuts and a powerhouse of nutrition. Healthy fats, proteins, minerals, and vitamins abound in almonds. The almond is extremely good in maintaining brain function, strengthening muscles, and extending life. Almonds are a good source of copper, iron, and vitamins, thus they can help with anaemia ***(Rao & Lakshmi, 2012)***.

Cashew nuts have the highest concentrations of copper and iron, which are both active components of red blood cells and are essential for their efficient functioning and formation. Copper aids iron metabolism and is necessary for energy generation as well as increased blood vessel, bone, and joint flexibility. It also helps to prevent cancer since it is high in antioxidants, which aid in the removal of free radicals ***(Kumawat et al., 2017)***.

According to the ***Hedge et al., 2016*** study, there was an increasing gradient in the younger age group towards chocolates and cadies, which was followed by a drop in soft drinks and snacks among the preferences. In ***Kumar et al., 2020*** study, bio-fortification and nutrient supplementation were used to boost nutritional intake. Increased intake of fruits and vegetables as part of a daily balanced diet had a positive impact on human health.

This beneficial effect on human health was not due to a single component or variety of vegetable. Consumption of a range of vegetables was found to have a higher protective impact against a number of chronic diseases. In a range of vegetables, there was a considerable combination of nutraceuticals in each type of vegetable. Incorporating a range of vegetable groups into one's diet has been shown to have a more favourable impact on human health, as well as a prophylactic action against chronic illnesses ***(Kumar et al., 2020).***

The physiological maturity at which fruits attain maximum dry weight, size, taste, total soluble solid (TSS), skin color and other characters were used as the guidance for fruits harvesting. Based on both field maturity and customer willingness vegetables were preserving efficiently. Further the vegetables and fruits had prevented from deterioration by efficient post harvest handling processes. One of the postharvest handling processes was processing of fruits and vegetables to prevent the losses. To overcome the loss, quality and nutrient fruits and vegetables were processed ***(Pokhrel, 2021).***

Due to these multiple benefits of vegetables like carrot, beetroot, pumpkin and nuts in minimal quantities like almonds and cashew nuts, will be used to formulate a healthy vegetable candy sheet to promote the nutritional status of underweight children by consumption of healthy snack.

Hence the present study titled "Development of Healthy Vegetable Candy Sheets for Underweight Children" was undertaken with the objectives.

- To develop value added healthy vegetable candy sheet using carrot, beetroot and pumpkin.
- To analyze nutritional composition, sensory evaluation & shelf life of the healthy candy sheets and
- To study the acceptability of the healthy vegetable candy sheets among School Going Under weight children.

II. REVIEW OF LITERATURE

The literature pertaining to the study field **"Development of Healthy Vegetable Candy Sheets for Underweight Children"** is reviewed under following headings:

A. Prevalence of health disorders with Protein and Energy Deficiencies - Global, Indian and Region wise scenario.
B. Need and Importance of Protein and Energy Rich Foods for Children.
C. Supplements with High Protein and Energy to Combat Deficiencies Disorders.

A. Prevalence of health disorders with Protein and Energy Deficiencies - Global, Indian and Region wise scenario.

Rahman et al., (2019) reported that under nutrition is the most important aspect in determining the morbidity and mortality rate among children under age five. In ***Ray et al., (2000)*** study, the prevalence of Malnutrition stated the rate as higher among the children grown up by an illiterate mother was about 63 per cent.

Three million deaths were attributed as a result of under nutrition among children less than five years of age population. These malnourished children were not received the required amount of food and nutrients essential for growth and development. ***(Lakkam et al., 2014)***

According to United Nations Children's Fund (UNICEF), globally almost 200 million children less than five years suffer from stunting and wasting. About 340 million children under the age five were affected from hidden hunger of vitamin and mineral deficiencies. These reflected a profound triple burden of malnutrition which was affected the survival, growth, and development of children living in nations. The triple burden of malnutrition was faced in many countries. In worldwide stunting, overweight, anemic and wasting prevalence among children under five years of age were reflected in 101 countries, 77 countries, 124 countries and 62 countries. ***(Henrietta, 2019).***

In a child's growth, the first six years of life were the most crucial period. During this period, 40 per cent of physical growth and 80 per cent of mental growth

had taken place. According to the report of third National Family Health Survey (NFHS -3) conducted during 2005 to 2006, around 43 per cent of children under five were underweight in India. Some of the nutritional status indicators like wasting, stunting, low birth weights, breastfeeding availability, and Vitamin A deficiency were higher in India as compared with USA and China. Several intermediate processes like household access to food, access to health service, and caring practices had been reflected due to child Protein Energy Malnutrition (PEM). ***(Kumar et al., 2016)***

In the developing world, children under the age of five were affected by undernutrition, stunting, wasting which attribute to 19 per cent, 15.5 per cent, and 14.6 per cent of deaths. Severe Acute malnutrition (SAM) children may undergo severe wasting, bilateral pedal edema, and Mid- Upper Arm Circumference (MUAC). Children admitted to hospital due to Severe Acute Malnutrition (SAM) occurrence rates had been raised from five per cent to 13 per cent. In hospitals, Marasmaus had been used as a clinical term to describe Protein Energy Malnutrition (PEM) among children possessed weight-for-age less than three SD and no edema. Kwashiorkor was a clinical term used to describe the children possessed weight-for-age more than three SD and bilateral pedal edema. The Marasmic Kwashiorkor term was declared as a clinical term to explain the children possessed with weight-for-age less than three SD and edema. ***(Ahmed et al., 2020)***

Based on the Cross-Sectional Study carried out by ***Kumar et al., (2016)*** in 500 Randomly Selected Households in the Slum area of Gurgaon among the children below six years of age, acute illness was detected among a point twenty-five per cent children, and chronic illness prevalence detection rate was 25 per cent. Including this, there is a presence of common type of nutrition deficiencies in children were Anemia, Protein Energy Malnutrition (PEM), Vitamin A, and B complex deficiencies. The prevalence of Protein Energy Malnutrition (PEM) in India had attributed to poor living conditions, illiteracy status of parents, higher number of siblings, poor utilisation of health services, poor nutritional services of children, faulty breastfeeding, and weaning practices in the family.

Third National Family Health Survey resulted that in India about eight million children under five years of age were affected by Severe Acute Malnutrition

(SAM). Malnutrition in India is considered higher than the other countries. About 67 per cent of deaths in children below five years of age were occurred due to the condition of undernutrition. ***(Burtscher & Burza, 2015)***

In India due to severe malnutrition, about 48 per cent of children under five were stunted and 43 per cent of children under five were underweight. One third of the world's malnourished children reside in India. About half of the world's malnourished population had been occupied in India, Bangladesh, and Pakistan. ***(Narayan et al., 2018)***

According to the Food and Agriculture Organization (FAO) statistics outlined in ***Aijaz et al., (2017)***, India had a greater undernourished population in the world. Based on 2014 to 2016 data, India possessed 15 per cent of undernourished people. India also ranked 97 among 118 countries on hunger 2016 data provided by International Food Policy Research Institute (IFPRIs) Global Hunger Index (GHI).

On the report of International Food Policy Research Institute (IFPRIs) Global Hunger Index (GHI) 2019, India ranked 102 out of 119 countries. Comprehensive National Nutrition Survey shows that children less than four years were stunted by 35 per cent, wasted by 17 per cent and 33 per cent were underweight. Based on the Cluster Randomized Control Study (CRCS) conducted in two districts of Maharashtra in Urban and Rural Slums reported that children lesser than five years of age were stunted by 17.1 per cent; wasted by 45.9 per cent and underweight by 35.4 per cent. ***(Murarkar et al., 2020)***

The crucial health challenges occur in Low and Middle Income Countries (LMICs) was child malnutrition. ***(Nagata et al., 2016).*** The Global burden of diseases in malnutrition has been increased by 11 per cent. Every year about four million children had been died due to malnutrition. A higher impact of malnutrition had been seen in Low and Medium Income Countries (LMICs). In 2020, about 149 and 45.4 million children under age five were stunted and wasted. This data were compiled from the 2021 joint report on Childhood Malnutrition by the United Nations Children Fund, World Health Organization (WHO), and World Bank group.

Bangladesh Demographic and Health Survey (BDHS) 2017 to 2018 reported that among children under age five, 31 per cent were stunted and nine per cent were

severely stunted; eight per cent were wasted and two per cent were severely wasted; 22 per cent were underweight and four per cent were severely underweight. The current COVID-19 situation had increased the incidence of childhood malnutrition. The study conducted along with the survey included 7,738 mother child pairs, and the participation record shows the moderate to severe malnutrition condition. ***(Rahman et al., 2021)***

Among the children belonging to the lower middle class, the prevalence of malnutrition was higher at about 58.7 per cent. ***(Hasan et al., 2011)***

The survey conducted by ***Sangeetha et al., (2018)*** in Tamil Nadu, Salem district rural area Anganwadi centers had been selected to assess the pattern of malnutrition among children below five years of age. Under this study, the prevalence of malnutrition on the clinical examination was 38.5 per cent in the majority of children who had thin, sparse, brown hair. The Mid Arm Circumference among the survey children were less than 13.5 for about 42.5 per cent of children. The nutritional status of the surveyed children had influenced by the mother's education and the number of siblings in the family.

Ezhumalai et al., (2015) revealed in the selected three districts based on Infant Mortality Rate (IMR) in Tamil Nadu had shown that the stunted children were 34.9 per cent and severely stunted were 11.1 per cent. This study also reported the prevalence of underweight were 25.7 per cent and severely underweight were five per cent. In Tamil Nadu, a descriptive Cross Sectional Study was conducted by ***Jasmine et al., 2020*** in Kancheepuram district which reported that the prevalence of underweight among the children was 52.4 per cent.

The total number of admissions during 1995 to 2015 in the nutrition ward of Tertiary Care Hospital in Hyderabad, undertaken by National Institute of Nutrition (NIN). Based on the total admission population nine per cent of cases were admitted due to Kwashiorkor and eight per cent of cases were admitted due to Marasmic Kwashiorkor and 61 per cent of cases were admitted due to Marasmus. The overall mortality rate during this period was two per cent. Among the overall mortality rate, 16 per cent of deaths were due to Kwashiorkor, 11.3 per cent of deaths were due to

Marasmic Kwashiorkor and 54.5 per cent of deaths were due to Marasmus. ***(Kulkarni and Mamidi, 2019)***

The periodic survey was carried out by NIN under the National Nutrition Monitoring Bureau (NNMB) for more than four decades (1975 to 2012) were stated in ***Kulkarni and mamidi, 2019*** study among the selected rural areas of 10 states in India. This survey declared that the prevalence of Kwashiorkor decreased from one per cent to near zero by 2011 to 2012; the prevalence of Marasmus decreased from one per cent to near zero by 2011 to 2012. These prevalence data were determined by the clinical findings.

Worldwide, children younger than five years of age were affected by Severe Acute Malnutrition (SAM). The approximation of about 14.3 million children younger than five years of age was caught up by under nutrition. ***(N'Diaye et al., 2020)***

Djoko et al., 2021 stated that Malnutrition is a major problem in Indonesia. World Health Organization (WHO) had stated that in Indonesia one in every ten children was affected by Malnutrition. To combat this issue they had proposed the agreement between Indonesia and 188 other United Nations countries. According to this agreement the Millennium Development Goals were declared to improve the status of poverty people. The eight points enclosed in the goals were also included the decreasing rate of child mortality, hungry, and poverty.

Based on the announcement of 2014 data, by the World Health Organization (WHO), United Nations Children's Fund (UNICEF) and World Bank the prevalence of stunted children were 116 million; wasted children were 51 million; underweight children were 99 million. This data depicts that Asia was highly influenced by undernourished children. Globally, the appearance of undernourished children based on United Nations Children's Fund (UNICEF) data declared that 90 per cent of the malnourished children resided in Asia and Africa; about 40 per cent of the malnourished children resided in India. The prevalence of undernutrition in rural area school going children was higher about 70 to 65 per cent as compared with the urban school going children. ***(Nasih et al., 2021)***

According to the result declared from the Cross Sectional Study by ***Bhattacharyya et al., 2020*** conducted in Meghalaya from both selected rural and urban children between six to twelve years of age. Among children between the ages of six to nine, the prevalence of underweight was 18.7 per cent and stunting was 17.2 per cent. About 19.1 per cent were experienced thinning; 23.2 per cent were undergoing stunting and 32.4 per cent were affected by nutritional deficiencies between children between 10 to 12 years of age.

In West Bengal children at the age of six to twelve years, the prevalence rate of undernutrition was 77.6 per cent in boys and 76.4 per cent in girls resulted from the Cross Sectional Study Conducted from 500 children. ***(Das et al., 2012)***

Srivastava et al., 2012, reported that the prevalence of Malnutrition among 384 children who belonged to five to fifteen years of age in Uttar Pradesh was wasting about 33.3 per cent and stunting about 18.5 per cent.

Based on ***Shivaprakash and Joseph, 2014*** study, total of 484 students from the rural school going children aged six to twelve years in Karnataka resulted in the prevalence of underweight and stunting. About 33.3 per cent were underweight and 27.9 per cent were stunting.

Chajhlana et al., 2017 conducted a cross sectional study in Hyderabad had carried out among the urban area children about 412 were chosen for this study. The result showed that the prevalence rate of Under Weight was about 29 per cent. Among the Under Weight children Prevalence of stunted height were 22 per cent; Children suffered from Vitamin A deficiency were nine per cent; Vitamin B deficiency were 15 per cent and Anemic were 16 per cent.

B. Need and Importance of Protein and Energy Rich Foods for Children

According to World Health Organization (WHO), Protein Energy Malnutrition (PEM) refers to "an imbalance between the supply of protein and energy and the body's demand for them to ensure optimal growth and function". It specifically occurred in preschool children less than six years of age and delivered a consequence from physical to cognitive growth so that they were prone to infection. An adequate amount of feeding had helped children to prevent and overcome

malnutrition and further determined the child's growth. According to age the feeding practices were changed. ***(Bhutia et al., 2014)***

Infected children may experience Under Nutrition or Malnutrition. Infection was closely linked to Malnutrition. The infected children may undergo nutrient loss, reduced uptake of food and increased energy requirements. This may lead to Under Nutrition and will increase the vulnerability of infection by reducing gut barrier functions, modifying the intestinal microbiota, altering the regulation of inflammatory adipocytokines, and limiting the uptake of micro and macronutrients. Due to infection micronutrient deficiencies (Iron, Zinc, Vitamins A, D, and B12) may occur. ***(Alaaraj et al., 2021)***

Prevalence of Under Nutrition has revealed by ***Bhutia et al., 2014*** was an increase of four-fold from 15.4 per cent (six months) to 52.6 per cent (12-23 months). This can lead to the early initiation of complementary feeds in the early months, late weaning, and an inadequate amount of complementary feeds in the early growth stage of the children.

In humans, IL-6 and TNF-alpha are the two pro-inflammatory cytokines that decreased muscle protein turnover, increased net muscle degradation, and accelerate protein degradation. These pro-inflammatory cytokines show significant disturbances on circulating amino acid, muscle wasting, and edema in kwashiorkor children. In intestinal microbiota, malnutrition-related changes may occur which attribute to the growth flattering, deregulated inflammation, and immune function. Pro-inflammatory cytokines reduce insulin secretion in Protein Energy Malnutrition (PEM) children. Due to this, the catabolism of protein is high and this leads to muscle wasting in Protein Energy Malnutrition (PEM) children. ***(Alaaraj et al., 2021)***

Ahmed et al., 2020 study had stated that stunted children may experience less attentive behavior, more anxiety, depression, and lower self-esteem when compared to non-stunted children. Every 10 per cent increase in stunting had been contributed to decrease the Preschool children dropping out by eight per cent.

According to ***Bhutia et al., 2014*** study, a low birth baby had grown along with the compromised feeding practices and infections were resulted in stunted

growth in both children and adolescent. Adolescent born with low birth weight were also giving birth to the underweight children in their later stages of life. Due to inadequate nutrition children were prone to infection. A single episode of infection affected in children was easy to regain their normal state of growth, but in repeated episodes of infection, it was difficult to regain its normal state of growth.

Presence of Malnutrition due to lack of food and infection were termed as Primary Malnutrition. In children, as a result of chronic diseases (Kidney, Liver, and Heart disease) they may experience Malnutrition which was termed as Secondary Malnutrition. In malnourished children, edema had been identified by pressing on the dorsum of the feet for three to five seconds and occurrence of indentation on the release of pressure indicates pedal edema. Marasmus is identified by severe wasting of muscles that are under the skin and no edema. Kwashiorkor is identified by lack of dietary protein, scanty hair, no interest in surroundings, and no appetite. Marasmic kwashiorkor is identified by a mild change in hair and skin and the presence of fatty liver and edema. ***(Ahmed et al., 2020)***

According to ***Narayan et al., 2018*** study, Severe Malnutrition had an impact on metabolic function, child behavior, and organ function. The immune system was affected in malnourished children, which increases the risk of infection. Motor and cognition functions of the malnourished children were also affected. Malnutrition had influenced the long term human development of malnourished children.

Several steps had been taken in food fortification to increase the nutritional content of the food and to improve the undernourished children's nutritional status. Hunger, ignorance of healthy diet, unhealthy feeding and caring practices, lifestyle, inadequate investment in health and other sectors, unsafe water are some of the common reasons for the Prevalence of Malnutrition. ***(Aijaz et al., 2017)***

Paruchuri et al., (2012) stated that Malnutrition is generally believed as a deprivation of minimal daily requirements. Starved children were also referred to as malnourished children. This malnutrition can arise in the children when their bodies didn't get an adequate amount of nourishment and can’t able to get proper nourishment from the food which has been consumed. Mostly malnutrition may take

place when there is an infection as some medical conditions or the character of food ingested.

In Protein Energy Malnutrition (PEM) children, the therapeutic feeding has been started first by giving milk-based foods to match with the children's reduced metabolic capacity. The purpose of giving initial feeding is to stimulate the metabolism, digestion, gut mobility, nutrient absorption, improve appetite, and decrease edema. Further, the appetite is reached to normal, and then the feeding of Ready-to-Use Therapeutic Food (RUTF) has been started to provide the children. Hence, the required amount of nutrients was met. ***(Bhutta et al., 2017)***

Protein is a basic macronutrient that is needed for the growth, development, and repair of cells present in the body. Psychological well-being was more influenced by long term protein deficiency. In the younger population, this Protein deficiency may further cause mental disturbance, tension, sorrow, surliness, and crankiness. Protein Energy Malnutrition (PEM) presented the liquid accumulation in children as a result of poor maintenance of liquid in the body called edema, improper functioning of organs, the immune system does not work actively, weakening and shrinkage of muscle tissues. ***(Khan et al., 2017)***

Arcieri et al., (2021) reported that, Kwashiorkor was a Protein deficiency which may decrease the albumin content in the blood. The albumin present in the body will increase the oncotic pressure inside the vasculature. When there is a deficiency it shows that there is an imbalance between the oncotic and hydrostatic pressure across the capillary blood vessels.

Community Management of Acute Malnutrition (CMAM) had been conducted in the Bihar state of India. The undernourished children had not been considered as the special care needed individual. The elderly people had considered that the condition of the undernourished children is an influence of witchcraft. Based on this behavior of the people the importance of undernutrition is unable to consider as a serious issue. Due to these the affected people rates are higher. ***(Burtscher & Burza, 2015)***

Indigenous Ready-to-Use Therapeutic Foods (RUTF) showed a higher amount of effectiveness in the management of Severe Acute Malnutrition (SAM)

under the Randomized Control Trial conducted at Chandigarh located in India. ***(Shewade et al., 2013)***

Malnourished children were more prone to infectious diseases. Malnourished children had encountered chronic illness and disabilities, undermined brain function, and endure the loss of physical and economical productivity. ***(Nagata et al., 2016)***

Lakkam et al., 2014 had spoken out about this Malnutrition issue, the three main aspects were important to acknowledge. The first aspect was the evolution of the weight and height of the children less than five years of age by the deficit of the food; the second aspect was the footprint that the height and weight had imprisoned on the mortality and morbidity of the children; the final third aspect was the effect of the supplementary and therapeutic foods observed in the weight and height of the children.

In Stunted children, the diminished reduction in the development of the beta cells may lead to the risk factor of the occurrence of Type - II Diabetes Mellitus. After six years of recovery from malnutrition, the children were highly prone to blood pressure. During the treatment of the malnourished children, the systolic and diastolic pressure of the blood was lower as compared with the normal children. ***(Nasih et al., 2021)***

When the supplementary foods provided to the malnourished children were lesser in quantity, quality, and variety also a major aspect in the occurrence of Malnutrition in School going children and Infants. ***(Santi et al., 2021)***

Majority of people in India were threatened by the nutritional problems. Malnutrition is an imbalance between both the macro nutrients and micro nutrients as a result of insufficient utilization of nutrients from the food by body and poor intake of food by an individual performed in a condition like internal and external environment. ***(Yadav and Dubey, 2017)***

C. Supplements with High Protein and Energy Foods to Combat Deficiency Disorders:

Guidelines and a three-phase management approach for managing Severe Malnutrition had been developed by World Health Organization (WHO). Phase one involves initial resuscitation and stabilization; phase two introduces nutritional rehabilitation; phase three involves follow-up for prevention of occurrence. ***(Arcieri et al., 2021)***

Nowadays, Ready-to-Use Therapeutic Food (RUTF) has been used as a prompt food strategy to overcome Protein Energy Malnutrition (PEM). Mostly Ready-to-Use Therapeutic Food (RUTF) prepared from various indigenous sources. In a recent study peanut, chickpea and mung bean had been used in the development of the Ready-to-Use Therapeutic Food (RUTF). Consumption of legumes and also the incorporation of legumes in the staple food may reflect a good improvement in the Protein Energy Malnourished individual. Hence the animal source of protein was higher in cost, peoples were more conscious in choosing the cost effective plant sources of Ready-to-Use Therapeutic Food (RUTF). The developed Ready-to-Use Therapeutic food (RUTF) using peanut, chickpea, mung bean showed good storage stability and better nutritional retention of the product. ***(Javed et al., 2021)***

Ready-to-Use Therapeutic Foods (RUTF) and Ready-to-Eat (RTE) foods were more suitable for children under the treatment of Under Nutrition. The mortality of children due to direct and indirect malnutrition had been higher worldwide. As compared the malnutrition of direct and indirect mortality rates, resulted that indirect rates of mortality were higher resulting in unsafe hygiene practices. This indirect malnutrition mortality rate among children under five years of age every year was estimated to cause 860,000 deaths. These Ready-to-Use Therapeutic Foods (RUTF) and Ready-to-Eat (RTE) foods were very effective in improving the nutritional status of malnutrition. ***(Awuchi et al., 2020)***

The prevalence of Severe Acute Malnutrition (SAM) was higher and the most crucial form of Under Nutrition. Severe Acute Malnutrition (SAM) also called as Severe Wasting. Based on the World Health Organization (WHO) standard guidelines, the standard Ready-to-Use Therapeutic Food (RUTF) had developed.

The study conducted in Pakistan which involved the study population of uncomplicated Severe Acute Malnutrition (SAM) children below five years of age. This study had done for eight weeks. Study resulted that there was a high improvement in the weight gain and developmental potential in the uncomplicated Severe Acute Malnutrition (SAM) children below five years of age. ***(Saleem et al., 2021)***

Malnourished children in Kenya was providing the fermented sorghum flour with pumpkin pulp and pumpkin seed flour incorporation had developed and analyzed the contribution of Protein, Iron, and Vitamin A content presented in the flour. Pumpkin pulp and seed flour were rich in Protein, Iron, and Vitamin A. The developed flour composition resulted that 22.87 per cent of Protein; 875.00µg RAE/100g of Vitamin A; and 27.51mg/100g of Iron were composed in the developed flour. This flour can attain 70 per cent of Protein, Vitamin A and Iron for the daily requirements of Preschool children in Kenya. Fermented sorghum flour incorporated with pumpkin pulp and seed flour is highly nutritious and helpful in eradicating nutritional deficiencies in preschool children. ***(Mbijiwe et al., 2021)***

A complementary food from sorghum, pumpkin seed flour, and carrot has been developed. In this complimentary food, sorghum and pumpkin seed flour are co-fermented to increase the nutritional quality of the food. Along with the fermented flour carrot has been added to meet the micronutrient requirements. The supplementary food should not only be high in energy, protein, and calorie rich food but also it should be enriched with vitamins and minerals by incorporating vegetables, fruits, and pulses. In this developed co-fermentation product both protein and beta carotene contents are immensely higher to meet the needs of the Undernourished children. ***(Nneka et al., 2019)***

Using pre gelatinized yellow maize, soya bean and cooked banana fruit has been used in the formulation of the therapeutic foods to combat severe acute malnutrition. These ingredients are then processed into flour which was higher in protein, energy, iron, zinc, and calcium. The formulated product is Ready-to-Eat Therapeutic Food (RUTF). This flour also met the Ready-to-Eat Therapeutic food (RUTF) requirements. The flours which are formulated have been suggested to combat the severe acute malnutrition in infants and children. Also, it has been priced

very lower, easily available at the markets, and highly beneficial for the mothers of children less than five years of age to prepare the formulated Ready-to-Eat (RTE) food at the household itself. The formulated flour is playing a crucial part in decreasing the lapse between the nutrient and energy in the transition period of growing children. ***(Yazew Tamiru, 2022)***

In the formulation of pre-gelatinized maize flour which has a different proportion of incorporation of soya bean and carrot flour. Generally, malted foods are rich in high energy and protein. Due to the addition of soya bean flour and carrot, the malted food becomes highly nutritious. Children consuming the malted cereals alone are suppressed by the children who are all consuming malted food cereal along with the legumes, vegetables, fruits, and nuts. These formulated foods are incorporated with carrot flour rich in antioxidants, Pro-Vitamin A carotenes, and improve the vision of the eye at night. ***(Echem et al., 2017)***

All children affected by severe acute malnutrition are not admitted to the hospital. Only the children with complicated severe acute malnutrition were admitted to the hospital for treatment. Other children with uncomplicated severe acute malnutrition were provided Ready-to-Eat (RTE) foods to improve their condition and monitored. For the management of Severe Acute Malnutrition Federation of the Indian Chamber of Commerce and Industry (FICCI) Research and Analysis center has prepared a food product that is equivalent to the Ready-to-Use-Therapeutic foods (RUTF) prepared as per the World Health Organization (WHO) guidelines. These FICCI products and Ready to eat therapeutic food are compared and analyzed which product is more effective in the management of severe acute malnutrition. This comparison shows that the average weight gain in the children who consumed Ready-to-Eat Therapeutic Food (RUTF) is higher than the food product prepared from FICCI. ***(Thapa et al., 2017)***

Indigenously prepared Ready-to-Use Therapeutic Food (RUTF) was supplemented to the severe acute malnutrition children of six to sixty months of age. Standard nutrition therapy as per the World Health Organization (WHO) was compared with the indigenously prepared Ready-to-Use Therapeutic Food (RUTF). In this comparative study, the rate of weight gain is higher as six g/kg/day among

the children supplemented with the Ready-to-Use Therapeutic Foods (RUTF). ***(Jadhav et al ., 2019)***

If the Ready-to-use therapeutic foods (RUTF) doses had been reduced in the management of the severe acute malnutrition (SAM) results in the lengthening the recovery duration of children and minimum amount of the negative effect on the growth had been reflected. To get the full effectiveness of the supplemented food, it had to be given continuously. ***(Burtscher & Burza, 2015)***

To recover the malnourished children from their inappropriate nutritional status the World Health Organization (WHO), the World Food Programme, and UNICEF had been suggested following the community based approaches. The Severe Malnutrition Children had been treated for recovery without an uncomplicated condition in the home itself was performed by the usage of Ready-to-Use Therapeutic Foods (RUTF). ***(N'Diaya et al., 2020)***

Randomized Control Trial (RCT) had been administered at Chandigarh, India to assess the efficacy of the indigenous Ready-to-Use Therapeutic Food (RUTF) by using the community based management approach for Severe Acute Malnutrition (SAM). As the Indigenous Ready-to-Eat Therapeutic Food (RUTF) had given to the children younger than five years of age showed the rate of weight gain by 13 g/kg. This Randomized Control Trial (RCT) expressed the effectiveness of the Ready-to-Use Therapeutic Foods (RUTF) for Severe Acute Malnutrition (SAM) children. ***(Shewade et al., 2013)***

Screening the accuracy of the child malnutrition management based on the community-based approach was performed by the improved mobile technology. To monitor the effectiveness of the supplemented foods to the malnourished children, modest mobile technology had been utilized. ***(Nagata et al., 2016)***

Among the Guatemalan communities, two derived policies were predicted and applied to conduct a simulation study. These study results delivered a decrease in the severity of the underweight by 14 per cent and the stunting severity was decreased by seven to eight per cent on the children less than 60 months of age. Under these policies, four per cent of the children were benefited to receive the food. The supplementary foods consisting of 100kcal/day were provided to the

Guatemalan community and expressed the efficiency in decreasing the rate of underweight and stunted children. ***(Lakkam et al., 2014)***

World Health Organization (WHO) suggested Moringa as a supplement food to use in the management of Malnutrition. Moringa was a nutritious food to supplement the feeding mother and the children during infancy. Moringa milk had been provided to malnourished children at a frequency of 4 times per day and also substituted with another malnutrition therapy. The malnourished children consuming Moringa milk for two months of regularity resulted in weight gain. ***(Djoko et al., 2021)***

Moringa Olifera is a cost effective locally available ingredient highly recommended for the development of supplementary foods for School going children. Importantly, 100 grams of Moringa leaves contain about seven grams of protein and 1 gram of crude fiber. These Moringa leaves were used in the development of nuggets by adding chicken of about 20 per cent. This nugget had supplemented with stunted children and the result shows that the higher efficiency of the moringa chicken nuggets in the prevention of stunting among School going children. ***(Santi et al., 2021)***

In ***Arokiamary et al., 2020*** study, prepared a supplementary food mix based on the pearl millet and had been incorporated about five per cent of Carrot and Araikeerai powder. Incorporation of Carrot and Araikeerai powder had provided extra essential nutrients needed for the growth and development of Children. This prepared supplementary food mix was enriching with Beta Carotene and Ascorbic acid

III. METHODOLOGY

The methodology pertaining to the study titled **"Development of Healthy Vegetable Candy Sheets for Underweight Children"** is discussed on four phases and is furnished under the following headings:

A. Selection of Ingredients and Production process of the Developed Healthy Vegetable Candy Sheets.
B. Standardization, Sensory evaluation, Nutritional analysis and Shelf life of the Developed Healthy Vegetable Candy Sheets.
C. Food Costing, Packaging and Labelling of the Developed Healthy Vegetable Candy Sheets.
D. Acceptability of the Developed Healthy Vegetable Candy Sheets among selected School going Children.

A. Selection of Ingredients and Production process of the Developed Healthy Vegetable Candy Sheets

Carrots are a classic root vegetable grown throughout the chilly season all over the world. Taproot is the edible part of a carrot. ***(Tushir and Bala et al., 2017)*** Carrots are high in Phytochemicals such as Carotenoids, Anthocyanins, and other Phenolic substances, as well as calories. Carrots are high in vitamin A carotenoids, notably alpha and beta carotene, which are vegan. (***Shafiq and colleagues, 2018***)

From ancient times Beetroot is considered as a nutritious vegetable to promote the good health. Beetroot was easily available vegetable at low cost in the market. Beetroots are rich source of dietary nitrate had a capable to reduce the blood pressure in human.***(Fatma et al., 2016)*** Beetroot was rich source of iron and folic acid to improve the Red Blood Cell (RBC) production and increase the level of hemoglobin. ***(Maheswari et al., 2013)***

Pumpkin is a seasonal crop that has been utilised for medicinal purposes for centuries. Pumpkins are high in Vitamin A, Vitamin C, and Beta-Carotene. Pumpkin has been used to cure diabetes, intestinal worms, and parasites for centuries. (***Muzzaffar et al., 2016***). As a result, vegetables including carrots (Daucus carota

subsp. sativus), beets (Beta vulgaris), and pumpkins (Curcurbita moschata) were chosen for the development of healthy vegetable candy sheets.

The approval for the proposed study was cleared from the Institutional Human Ethics Committee (IHEC) of Avinashilingam Institute for Home Science and Higher Education for Women, and is given as Appendix - I. (Approval No. AUW/IHEC/FSMD-21-22/XPD-14)

The selected major ingredients were washed under running tap water, pat dried with towel and the inedible portion was removed. Vegetables were peeled and cut into small pieces. Using steamer, the vegetables were steamed for ten minutes. The steamed vegetables were cooled. The cooled vegetables were ground into a fine paste in the mixer.

Minor ingredients for the Vegetable Candy Sheets were Almonds, Cashew nuts, Sugar, Pectin, Citric acid and Cardamom procured from the local market in Coimbatore.

Almonds include a lot of good fats, proteins, minerals, and vitamins. Almonds contributed to muscle strength and mental vibrancy. ***(Rao and Lakshmi, 2012)***

Cashew nut promotes the health with its high nutritional properties.***(Iqbal et al., 2021)*** Cashew nut was rich in copper and iron helpful in the production of Red Blood Cells (RBC). ***(Kumawat et al., 2017).*** The almonds and cashews were dry roasted in a pan. Roasted nuts were cooled down and grinded into fine powder. Grinded vegetable, nuts mixture, sugar and pectin were boiled till reaches the flowing consistency. Finally citric acid was added as a preservative and poured into the rectangular glass mould. The mold was dried in microwave oven at 100 Celsius for 40 minutes. Sheets were removed from the mold and dried the back side of sheet for 20 minutes. After the sheets were dried and cut it into small rectangular sheets. The sheets were than stored in a Zip lock plastic cover for further analysis.

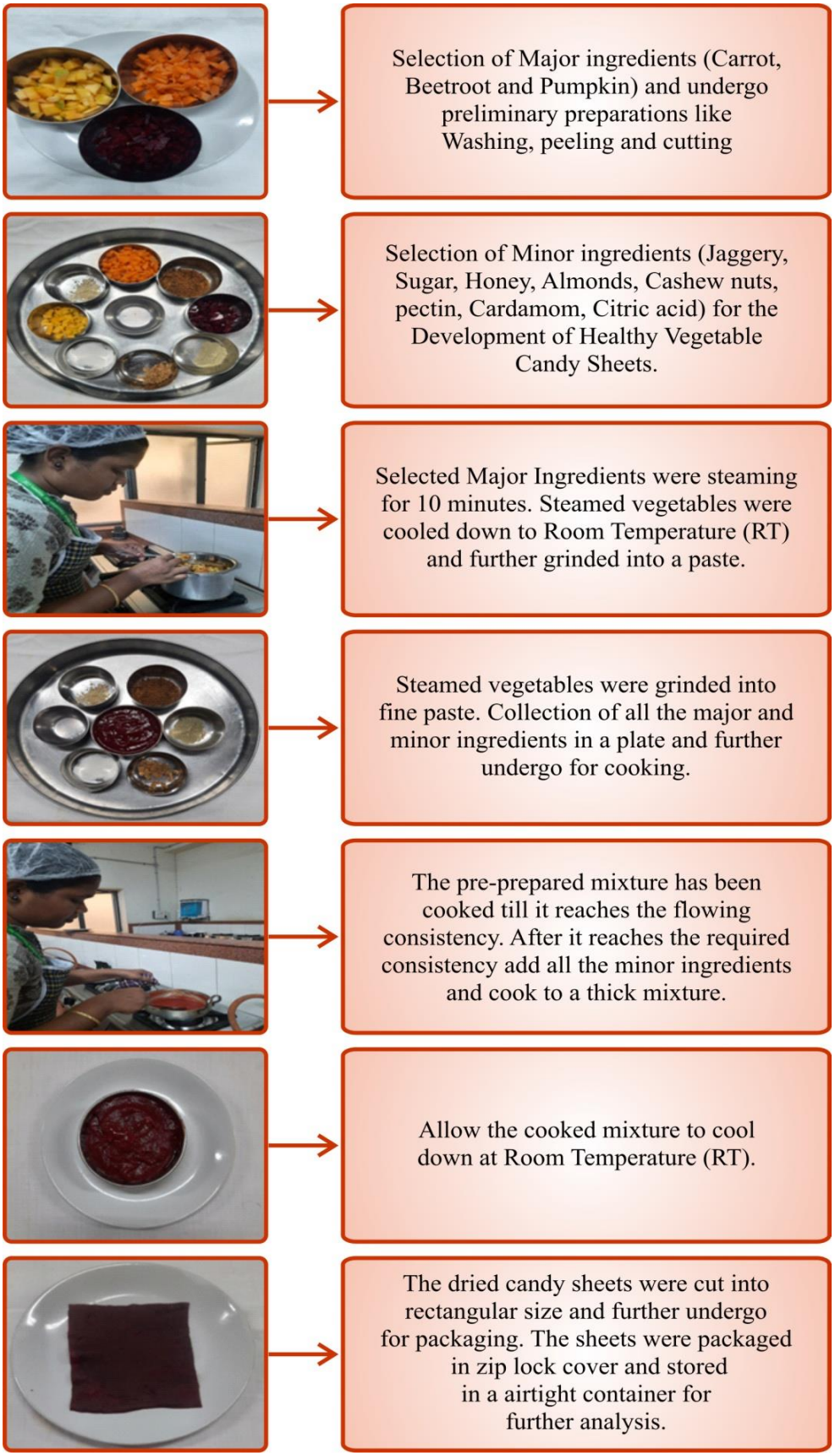


Figure 1: Production Process of Vegetable Candy Sheets

Drying - The rectangular shaped mould is greased with butter and the mixture was spreading as a thin sheets. The mold was drying in the microwave oven at 100º Celsius for 40 minutes. Then the sheets were peeled from mould and dried the back side of the sheet at 100º Celsius for 20 minutes. After the sheet dried completely, sheets were allowed for cooling to Room Temperature (RT).

B. Standardization, Sensory evaluation, Nutritional analysis and Shelf life of the Developed Healthy Vegetable Candy Sheets

Standardized recipes are those that were tried, adjusted, and retried repeatedly in order to give steadily satisfactory results and yields when the accurate and consistent methodologies are implemented with the same type of equipment and the same quantity and quality of ingredients every time.

Recipe standardisation is required for a variety of reasons. Each time the standard recipes are followed, the quality of the product will be consistent. The targeted number of servings will be achieved by utilising a standardised recipe. In standardised recipes, nutritional values per serving will be constant. Because the same components and quantities of ingredients are used each time the dish is created, standardised recipes give consistent information for food cost control. It's handy for buying since the quantity and quality of food needed for production can be simply predicted using a standardised recipe. It is possible to forecast the exact amount of labour requirements and even to make the best use of their time on any given day.

Hence, Vegetable Candy Sheets were tested three times to record the preparation, production details such as proportions of Ingredients, equipments cooking time, method of preparation, yield and portion size.

As a part of standardization process, trials were done to quantify the ingredients, pre-preparation process, cooking time, temperature for drying, method of cooking and yield.

First trial was that the candy sheet was prepared without addition of sugar, pectin and cardamom. The result was that the product did not dried and takes more

time for drying. Even though, it is dried the sheets were become crisper and not able to remove from the container. The sheets were sticking to the container.

Second trial was that the candy sheet was prepared by the addition of sugar and cardamom. The result was that the product formed like a sheet. But the sheets were too thin and not in required consistency.

Third trial was that the candy sheet was tried by addition of pectin to make the candy sheets as a thick sheet. As a result thick candy sheets were formed.

Fourth trial was that the candy sheet was prepared as a jam like consistency. While drying the water content in the vegetable paste mixture was dried and the sheets were cracked and not dried as a sheet texture. Sheets were dried in irregular shape and texture.

Fifth trial was that the candy sheet tried as a thick paste like consistency and then dried. The sheets came out well without any cracking on the surface of the sheet.

Sixth trial was that the candy sheet was compared with the texture obtained while drying the sheets using Microwave Oven and Oven/ Toaster /Griller (OTG) at the temperature of about 100 degree Celsius for 60 minutes. The sheets dried in the Oven /Toaster /Griller (OTG) was thick and very hard in texture as compared with the sheets dried in Microwave Oven. Hence, the candy sheets were dried using Microwave Oven provided a required texture for candy sheet.

Seventh trial was that the candy sheet tried with the addition of Sugar, Honey and Jaggery. Three candy sheets were prepared in this trial for comparison of the sweetness in the Sugar, Honey and Jaggery. After the preparation of three sweetened candy sheets were further carried out for sensory evaluation to assess the overall acceptability of the developed product. The Product which scored higher has been finalized for the standardization process.

TABLE 1

Formulation of standardized trials of Healthy Vegetable Candy Sheets

Standardiza-tion Trails	Carrot	Beetroot	Pumpkin	Sugar/ Honey/ Jaggery	Almonds	Cashew nuts	Pectin	Citric acid	Cardamom
Trial 1	30g	30g	30g	0	2.5g	2.5g	0	1g	0
Trial 2	30g	30g	30g	10g(Sugar)	2.5g	2.5g	0	1g	2g
Trial 3	30g	30g	30g	10g(Sugar)	2.5g	2.5g	2g	1g	2g
Trial 4	30g	30g	30g	10g(Sugar)	2.5g	2.5g	2g	1g	2g
Trial 5	30g	30g	30g	10g(Sugar)	2.5g	2.5g	2g	1g	2g
Trial 6	30g	30g	30g	10g(Sugar)	2.5g	2.5g	2g	1g	2g
Trial 7	30g	30g	30g	10g(Sugar)	2.5g	2.5g	2g	1g	2g
	30g	30g	30g	10g(Honey)	2.5g	2.5g	2g	1g	2g
	30g	30g	30g	10g(Jaggery)	2.5g	2.5g	2g	1g	2g

The candy sheets were prepared by using three sweeteners like Sugar, Honey and Jaggery. Sensory evaluation had done for these three sheets and the sheets scored higher had been chosen for further variations.

Figure 2: Sensory evaluation of candy sheets prepared by addition of ten grams of Sugar / Honey / Jaggery

After Seven time trial, the finalized candy sheets were prepared for three times for standardization to ensure the yield as same amount while repeating the process.

TABLE 2

Variations for the Development of Healthy Vegetable Candy Sheets

Ingredients	Variations							
	ABC1	ABC2	ABC3	ABC4	ABC5	ABC6	ABC7	ABC8
	1:1:1	2:0.5:0.5	0.5:2:0.5	0.5:0.5:2	1:1:1	2:0.5:0.5	0.5:2:0.5	0.5:0.5:2
	With Honey (in grams)				With Jaggery (in grams)			
Carrot	30	60	15	15	30	30	15	15
Beetroot	30	15	60	15	30	15	60	15
Pumpkin	30	15	15	60	30	15	15	30
Sugar/ Jaggery	10	10	10	10	10	10	10	10
Almond	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Cashew nut	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Pectin	2	2	2	2	2	2	2	2
Cardamom	2	2	2	2	2	2	2	2
Citric acid	1	1	1	1	1	1	1	1

Figure 3: Vegetable Candy Sheets with Honey

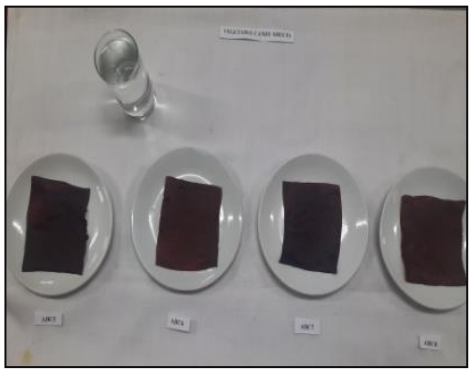


Figure 4: Vegetable Candy Sheets with Jaggery

The developed candy sheet Variations were ready for further sensory analysis. From the score obtained in sensory evaluation, the product which score high marks was finalized and further allowed for nutritional analysis, shelf life analysis, packaging, food labeling and food costing.

The sensory attributes of appearance (visual appeal on sight), colour (appropriateness of complexion and homogeneity), aroma (sense of smell feeling on inhaling the head space volatiles), taste (taste bud response on chomping), texture (force of chew and consistency on melting), and overall acceptability (resemblance

to commercial products) were examined. Sensory evaluation necessitates the involvement of panel members, whose responses to the product under test are documented as test results.

As demonstrated in the appendix, recipes were generated, and the sensory features of the developed Healthy Vegetable Candy Sheets were evaluated using the Five Point Hedonic Scale. Sensory Evaluation of Developed Healthy Vegetable Candy Sheets in the Laboratory: Twenty-five panel members were selected.

Panel members were given water to drink before and after tasting the product so that the flavour of the first sample would not stay in their mouth and alter the taste of the second sample. The total scores acquired were used to generate the sensory evaluation's mean score.

Figure 5: Sensory evaluation done for Variations in Candy sheets preparation

TABLE 3

Sensory score card for the developed eight variations of Healthy Vegetable Candy Sheets

Variations	Appearance	Taste	Texture	Flavor	Taste	Overall Acceptability
With Honey						
ABC1						
ABC2						
ABC3						
ABC4						
With Jaggery						
ABC5						
ABC6						
ABC7						
ABC8						

Appearance : 5 - Smoothy layer; 4 - Good; 3 - Average; 2 - Irregular layer; 1 - Very irregular layer.

Colour : 5 - Bright and colourful; 4 - Good; 3 - Average; 2 - Dull; 1 - Very dull.

Texture : 5 - Thicker; 4 - Good; 3 - Average; 2 - Slightly thicker; 1 - Very thinner.

Flavour : 5 - Excellent flavour; 4 - Good flavour; 3 - Moderate flavour; 2 - Unpleasant flavour; 1 - Very unpleasant flavour.

Taste : 5 - Sweeter; 4 - Moderately sweeter; 3 - Slightly sweeter; 2 - Less sweeter; 1 - Very less sweeter.

The five point hedonic scale shows 1-dislike very much, 2- dislike slightly, 3-neither like nor dislike, 4-like slightly and 5-like very much. By analyzing the sensory evaluation, the variation which has scored high and had overall acceptability has been standardized.

The prepared Healthy Vegetable Candy Sheets was packed in high-density polyethylene bag (HDP). Healthy Vegetable Candy Sheets was stored in room temperature (27+_3 degree Celsius). Also the Vegetable Candy Sheet The packed candy was unwrapped at a regular interval to asses through organoleptic test for color, flavor, taste, texture and overall acceptability. The spoilage was determined by organoleptic rejection and visual microbial growth.

For shelf life analysis, the direct technique was utilised, and a real-time study was recorded, which consisted of storing the product under conditions comparable to those it would meet in the real world, and monitoring its evolution at regular intervals. The key benefit of this approach was that it produced a very precise estimate of how long it takes for a product to decay. This investigation took a long time and did not take into account the fact that the product's storage conditions were not always consistent over time.

The developed and dried Vegetable Candy Sheet was analyzed for shelf-life. The 15g of the developed Vegetable Candy Sheet which was fully developed was kept in an air-tight packaging. The packets were first washed thoroughly and then they were dried without leaving any moisture content. The packets were wiped with clean white cotton cloth to prevent any dust and moisture as these may be invaded as a cause for the spoilage of the product. Then the Developed Vegetable Candy Sheet was added in the dried form and it was made sure that the packets were closed properly. The packets were then kept in a dry place in room temperature. The packets were also kept in a refrigerator to analyze the shelf life of the Developed Vegetable Candy sheets. The shelf life of both room temperature and refrigerator has been compared and analyzed. Direct method has been used to analyze the shelf life of the product.

The developed Vegetable candy sheet was given for the nutrient analysis and the nutrient content of major nutrients such as Energy, Carbohydrates, Protein, Fat and Fibre are the major nutrients. The minor nutrients such as Beta carotene, Iron, Vitamin C and Folic acid also been analyzed. The nutrient content was analyzed according to the nutrients which are prominent in the selected vegetables. The sample Variation 5 (ABC5) got the highest mean score and acceptability and hence it is taken for nutrient analysis.

C. Food Packaging, Labelling and Costing of the Developed Healthy Vegetable Candy Sheets

Standardized recipes portion food costs were calculated using an MRP (Material Requirement Program) system, and the unit prices involved in the food cost analysis were acquired from a purchase list of main and minor ingredients obtained from a local retail market. The cost of food was determined using the gross weights of the items and prices were linked to Indian Rupees.

Confectionery products are commonly consumed by the public at large and are generally used for taste and desire. They are getting incredibly popular, specifically among youngsters and teens. Pastries, cakes, candies, chewing gums, and chocolates are some of the several varieties of confectionery goods available in the market.

The produced Vegetable Candy Sheet's packaging is critical for distribution, storage, and sales. The produced Vegetable Candy Sheet was wrapped in such a form that the product's superior qualities were retained. Candy packaging serves as a barrier to the degradation of candy sheets by blocking chemical and microbiological interactions. The key functional packaging needs for sugar candies and chocolates are protection from dust, dirt, and other contaminating agents, moisture / water vapour pickup or loss resulting in sugar and fat bloom, stickiness, hardness, desiccation, rancidity owing to interaction with moisture and oxygen, colour and scent loss and tainting, and physical damages such as dusting, breaking, and loss of form.

According to ***Arokiamary et al., 2020 study***, Food packaged in Polyethylene Terephthalate (PET) jars showed minimum loss of Beta Carotene and Ascorbic acid. The developed Candy Sheet had packed in Polyethelene Terephthalate (PET) jar. The jar was sterilized then used for packaging.

According to the Food Safety and Criteria (Packaging and Labeling) Regulations (2011), fruits and vegetables must be packaged in aseptic and flexible packaging materials of food grade quality that meet BIS standards (Bureau of Indian Standards). The name of the food, a list of ingredients, nutritional information, a statement of vegetarian or non-vegetarian status, food additives, net amount, the

manufacturer's name and complete address, lot/code/ batch identification, date of production or packing, best before and use by dates, country of origin for imported food, and instructions for use were all required to be included on the labelling of pre-packed food.

Figure 6: Packaging of Vegetable Candy Sheets

Food costing is the most important tool in verifying whether the food cost targets were being met or not. This food costing has a direct effect on the profit. This only include the ingredients used and does not include the others. Product costing was helpful in knowing the food cost needed for the preparation of candy. This costing will show how much profit we will get on per candy. Food costing plays an significant role in deciding the selling price of the one serving of the candy sheet.

The food costing has been calculated by using the below given formula.
Cost per portion = Total cost / No. of Serving X overhead cost (1.66)

D. Acceptability of the Developed Healthy Vegetable Candy Sheets among selected School going Children

The developed Healthy Vegetable Candy Sheets had been further carried out to analyze the acceptability among the school going children. For this acceptability analysis 50 School going Children had been selected from Avinashilingam school, Coimbatore.

The finally finished product has been undergone for sensory evaluation among the 50 selected School Going Children. The acceptability of the developed Vegetable Candy Sheets had been analyzed among School Going Children. The sensory score sheet has been provided to the selected School Going Children. A five

point hedonic scale has been selected to score the sensory attributes of the developed product. The attributes that are analyzed in this sensory evaluation are Appearance, Color, Texture, flavour, Taste and Overall acceptability.

TABLE 4

Sensory score card to evaluate the acceptability among School going Children

Code	Appearance	Color	Texture	Flavour	Taste	Overall acceptability
ABC5						

Appearance : 5 - Smoothy layer; 4 - Good; 3 - Average; 2 - Irregular layer; 1 - Very irregular layer.

Colour : 5 - Bright and colourful; 4 - Good; 3 - Average; 2 - Dull; 1 - Very dull.

Texture : 5 - Thicker; 4 - Good; 3 - Average; 2 - Slightly thicker; 1 - Very thinner.

Flavour : 5 - Excellent flavour; 4 - Good flavour; 3 - Moderate flavour; 2 - Unpleasant flavour; 1 - Very unpleasant flavour.

Taste : 5 - Sweeter; 4 - Moderately sweeter; 3 - Slightly sweeter; 2 - Less sweeter; 1 - Very less sweeter.

These sensory results showed the degree of acceptability of Developed Vegetable Candy Sheet among School going Children. This result declared the efficient use of Vegetable Candy Sheet for Underweight children.

Figure 7 : Sensory acceptability of Developed Vegetable Candy Sheets among School Going Children

Flow Chart of The Study on Development of Healthy Vegetable Candy Sheets for Underweight Children

PHASE 1

Selection of Ingredients and Production Process of the Developed Healthy Vegetable Candy Sheets

- •Carrot
- •Beetroot
- •Pumpkin
- •Almonds
- •Cashew nuts
- •Sugar
- •Honey
- •Jaggery
- •Pectin
- •Cardamom
- •Citric acid

1. Selection of ingredients
2. Washing, peeling and cutting of vegetables.
3. Steaming of vegetables for ten minutes.
4. Grounding of steamed vegetables
5. Cooking all the ingredients to thick paste.
6. Addition of citric acid as preservative.
7. Sheeting the mixture.
8. Drying in microwave oven.
9. Packaging and storing in a air-tight container.

PHASE 2

Standardization, Sensory evaluation, Nutritional analysis and Shelf life of the Developed Healthy Vegetable Candy Sheets

Trial run for the product – Seven trials were carried out by the addition of different sweeteners as Sugar, Honey and Jaggery.
Variations for the product – From the trial, the highest scored sheets were chosen. Among three sweeteners two has been chosen. Further different proportion of vegetables categorized with the addition of these two sweeteners and sensory evaluation carried out.
Sensory evaluation-The candy sheets were subjected to sensory evaluation for appearance, colour, texture, taste and overall acceptability.
Standardization of the product – The sheets scored higher were standardized and repeated for three times to get the same yield at each time of preparation.
Nutritional analysis -The standardized product was analyzed for nutrients such as Energy, Carbohydarte, Protein, Fat, Fibre, Iron, Beta-Carotene, Vitamin C and Folic acid.
Shelf life analysis of the developed product was carried out by using direct method.

PHASE 3

Food costing, Packaging and Labelling of the Developed Healthy Vegetable Candy Sheets

- •Candy sheets were packed in a high density polyester bag with zipper seal air tight packages.
- •For packaging purpose of candy sheet food labelling were designed.
- •To commercialize the candy sheet for Underweight children, food costing had carried out.

PHASE 4

Acceptability of the Developed Healthy Vegetable Candy Sheets among selected School Going Children

The developed final product of Vegetable Candy Sheets were given to the selected School Going Children to assess the acceptability among them and sensory evaluation has been carried out.

IV. RESULTS AND DISCUSSION

The results obtained in the present study entitled **"Development of Healthy Vegetable Candy Sheets for Underweight Children"** are presented under the following headings:

A. Selection of Ingredients and Production process of the Developed Healthy Vegetable Candy Sheets
B. Standardization, Sensory evaluation, Nutritional analysis and Shelf life of the Developed Healthy Vegetable Candy Sheets
C. Food Costing, Packaging and Labelling of the Developed Healthy Vegetable Candy Sheets
D. Acceptability of the Developed Healthy Vegetable Candy Sheets among selected School going Children

A. Selection of Ingredients and Production process of the Developed Healthy Vegetable Candy Sheets

The Healthy Vegetable Candy Sheet was formulated specifically for the Underweight Children. Adequate amount of nutrients were not regularly consumed by the undernourished children. To reduce the rate of undernourished children the healthier snack option had formulated and developed.

In the formulation of Healthy Vegetable Candy Sheet three vegetables were selected. Carrot, Beetroot and pumpkin were the three vegetables which were selected for the formulation of healthy vegetable candy sheet. Almonds and cashew nuts were to make the product as protein and energy dense with micronutrients such as iron and folic acid. Cardamom is a spice which has been added to impart the flavour to the healthy vegetable Candy Sheet. Lemon juice was added as a natural preservative.

TABLE 5

Selection of Ingredients

S. No	Ingredients	Quantity
1.	Carrot	30g
2.	Beetroot	30g
3.	Pumpkin	30g
4.	Almonds	2.5g
5.	Cashew nuts	2.5g
6.	Pectin	2g
7.	Sugar / Honey / Jaggery	10g
8.	Cardamom	2g
9.	Lemon juice (Citric acid)	1ml

Figure 8: Selection of Ingredients for Healthy Vegetable Candy Sheet

Generally candies were sweet, so three sweeteners have been selected for the formulation of Healthy Vegetable Candy Sheet. The sweeteners selected for the formulation of Healthy Vegetable Candy Sheets were Sugar, Honey and Jaggery. Using these three sweeteners three variations of Candy Sheets had been prepared and named them as AAA - Sugar; BBB - Honey and CCC- Jaggery. Further the three variations of Vegetable Candy Sheets undergo for Sensory evaluation by seven Semi - trained panel members from Avinashilingam Institute of Home Science and Higher Education for Women, Coimbatore. The resulted score from Sensory evaluation had examined that CCC - Jaggery variation scored higher than the other two variations followed by BBB - Honey and AAA - Sugar. Hence, the candy sheet prepared using Jaggery has been finalized and further undergo for the standardization of the product.

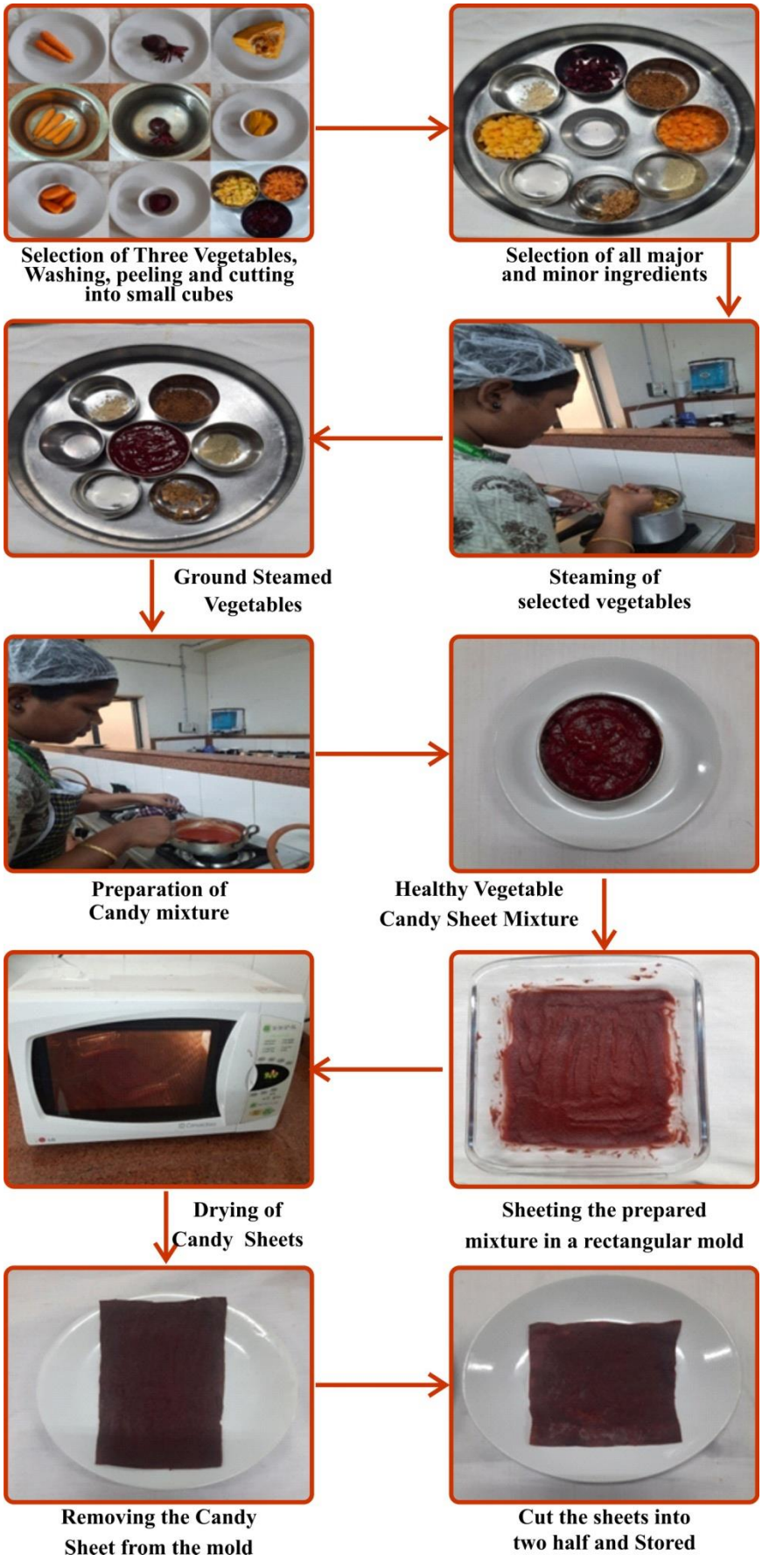


Figure 9: Preparation of Vegetable Candy Sheet

B. Standardization, Sensory evaluation, Nutritional analysis and Shelf life of the Developed Healthy Vegetable Candy Sheets:

Candy sheets prepared using Jaggery has been prepared for three times with the similar quantity, method of preparation, cooking time and drying method to yield the same product as a final yield. Finally the product developed using Jaggery has been standardized.

TABLE 6

Formulation of trials of Healthy Vegetable Candy Sheets

Trails	Carrot(g)	Beetroot(g)	Pumpkin(g)	Sugar/ Honey/ Jaggery (g)	Almonds(g)	Cashew nuts(g)	Pectin(g)	Citric acid(g)	Cardamom(g)
Trial 1	30	30	30	0	2.5	2.5	0	1	0
Trial 2	30	30	30	10 (Sugar)	2.5	2.5	0	1	2
Trial 3	30	30	30	10 (Sugar)	2.5	2.5	2	1	2
Trial 4	30	30	30	10 (Sugar)	2.5	2.5	2	1	2
Trial 5	30	30	30	10 (Sugar)	2.5	2.5	2	1	2
Trial 6	30	30	30	10 (Sugar)	2.5	2.5	2	1	2
Trial 7	30	30	30	10 (Sugar)	2.5	2.5	2	1	2
	30	30	30	10 (Honey)	2.5	2.5	2	1	2
	30	30	30	10 (Jaggery)	2.5	2.5	2	1	2

As a part of standardization process, seven trials were done to quantify the ingredients, pre-preparation process, cooking time, temperature for drying, method of cooking and yield.

TABLE 7

Trial 1 (A1BC)

Figure (A1BC)	
Preparation	In first trial, the ingredients selected to prepare are Carrot, Beetroot, Pumpkin, Almonds, Cashew nuts, Citric acid. This trial was preparing without the addition of sugar, pectin and cardamom.
Observation	The observation was that the product is not dried and takes more time for drying. Even though, it is dried the sheets were become crisper and not able to remove from the container. The sheets were sticking to the container.
Appearance	The surface of the candy sheet was uneven.
Colour	The colour of the candy sheet was bright in colour.
Texture	The final product of the candy sheet had become a papad like texture. This texture has obtained as a result of not adding the sugar.
Drying	The Candy sheets were dried at 100º Celsius for 45 minutes. The sheet takes more time for drying and not dried properly. Even though, it is dried the sheets were become crisper and not able to remove from the container.

TABLE 8

Trial 2 (A2BC)

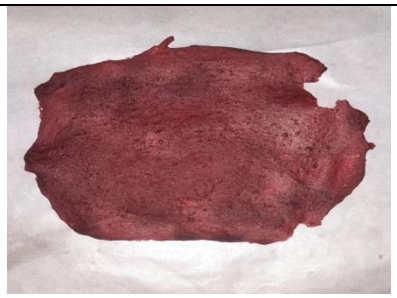
Figure (A2BC)	
Preparation	In second trial, the ingredients selected to prepare Candy sheet are Carrot, Beetroot, Pumpkin, Sugar, Almonds, Cashew nuts, Citric acid and Cardamom. This trial was preparing without the addition of pectin.
Observation	The result was that the product formed like a sheet. But the sheets were too thin and not in required consistency. In this trial the sugar gives the sheeting texture but the thickness of the sheet is not obtained based the required thickness of candy. Also the taste of the candy sheet is not appealing due to the addition of vegetables. In this prepared candy sheet the beetroot flavour is over powering and dominant. Hence two grams of cardamom powder had been added to make the product as appealing in taste acceptability.
Appearance	The surface of the candy sheet was smooth and even.
Colour	The colour of the candy sheet was bright in colour.
Texture	The final product of the candy sheet was too thin. To increase the thickness of the sheet pectin has to be added.
Drying	The Candy sheets were dried at 100º Celsius for 45 minutes.

TABLE 9

Trial 3 (A3BC)

Figure (A3BC)	
Preparation	In third trial, the ingredients selected to prepare Candy Sheets are Carrot, Beetroot, Pumpkin, Sugar, Almonds, Cashew nuts, Pectin, Citric acid and Cardamom.
Observation	The candy sheet was prepared by addition of pectin to make the candy sheets as a thick sheet. As a result thick candy sheets were formed. Addition of two grams of pectin to the formulation of candy sheet had act as a thickener to make a candy sheet as thick as the standard candy sheet requirements. Pectin had aided the sheets to obtain their required thickness. This thickness is very much essential for the setting of the candy sheets.
Appearance	The surface of the candy sheet was even.
Colour	The colour of the candy sheet was bright in colour.
Texture	The texture of the Candy Sheet was good and met the requirements of the candy sheet texture.
Drying	The Candy sheets were dried at 100º Celsius for 45 minutes.

TABLE 10

Trial 4 (A4BC)

Figure (A4BC)	
Preparation	In fourth trial, the ingredients selected to prepare Candy Sheets are Carrot, Beetroot, Pumpkin, Sugar, Almonds, Cashew nuts, Pectin, Citric acid and Cardamom.
Observation	The candy sheet was prepared as jam like consistency. While drying the water content in the vegetable paste mixture was dried and the sheets were cracked and not obtained as a sheet texture. Sheets were dried in irregular shape and texture. Due to the jam consistency the moisture present in the mixture had not completely evaporated during cooking. Hence while drying the moisture has been dried separately and the mixture has dried at different timing and the formation of crack in the sheet has been observed. This cracking texture does not provided acceptability for the prepared candy sheet.
Appearance	The surface of the candy sheet was cracked while drying.
Colour	The colour of the candy sheet was uneven in colour.
Texture	The texture of the Candy Sheet was cracked and not evenly dried. This cracking texture had not provided the acceptability for the prepared Candy Sheet.
Drying	The Candy sheets were dried at 100º Celsius for 45 minutes.

TABLE 11

Trial 5 (A5BC)

Figure (A5BC)	
Preparation	In fifth trial, the ingredients selected to prepare are Carrot, Beetroot, Pumpkin, Almonds, Cashew nuts, Citric acid.
Observation	The Candy Sheet was prepared as a thick paste like consistency and then dried. The sheets came out well without any cracking on the surface of the sheet. In this trial the mixture had prepared as thick consistency and then dried in at 150 degree Celsius for 20 minutes and then dried at another side for 10 minutes in Oven / Toaster / Griller (OTG).
Appearance	The surface of the candy sheet was uneven. Sheets dried using Oven / Toaster / Griller (OTG) had become crispy in the sides and corners of the sheet and moist in the centre of the sheet.
Colour	The colour of the candy sheet was slightly darker in colour.
Texture	The texture of the Candy Sheet does not come out well. The Corners of the sheet was crisp and the middle portion is very moist.
Drying	The Candy sheets were dried in Oven / Griller / Toaster (OTG) at 150º Celsius for 20 minutes. Due to this high temperature for short time the corners of the sheet had become crispier.

TABLE 12

Trial 6 (AMBC, AOBC)

Figure (AMBC, AOBC)	  AMBC AOBC
Preparation	In sixth trial, the Candy sheets prepared had compared with the texture obtained while drying the sheets using Microwave Oven and Oven / Toaster / Griller (OTG) at the temperature of about 100º Celsius for 60 minutes.
Observation	The sheets dried in the Oven /Toaster /Griller (OTG) was thick and very hard in texture as compared with the sheets dried in Microwave Oven. The corners of the sheets were crispy and hard in sheets dried in Oven / Toaster / Griller (OTG). But the corners of the sheets prepared using the microwave oven was not turned crisp while drying. Hence, the candy sheets were dried using Microwave Oven provided a required texture for candy sheet.
Appearance	Both OTG and Microwave oven dried sheets have smooth surface.
Colour	.The Candy Sheets dried using OTG and Microwave oven was bright red in colour.
Texture	The OTG dried Candy Sheet was thick and hard in texture. But the texture of Candy Sheets dried using microwave oven is obtained in required texture as thick and moist Candy Sheets.
Drying	In both OTG and Microwave Oven the Candy Sheet was dried at 100º degree Celsius for 40 + 20 minutes.

TABLE 13

TRIAL 7 (AAA, BBB, CCC)

Figure (AAA, BBB, CCC)	
Preparation	In the seventh trial, the ingredients selected to prepare are Carrot, Beetroot, Pumpkin, Sugar, Honey, Jaggery, Almonds, Cashew nuts, Pectin, Cardamom and Citric acid. In this trial three sweeteners had been used to compare the higher acceptability of sweetness.
Observation	In the seventh trial, the candy sheet was prepared with the addition of Sugar, Honey and Jaggery. Three candy sheets were prepared in this trial for comparison of the sweetness in the Sugar, Honey and Jaggery. After the preparation of three sweetened candy sheets were further carried out for sensory evaluation to assess the overall acceptability of the developed product. The Product which scored higher has been finalized for the standardization process.
Appearance	The surface of all the three (AAA, BBB, CCC) remains the same. Appearance of Candy sheet was smooth and good.
Colour	The colour of the candy sheet AAA prepared using Sugar was in bright colour; BBB prepared using Honey shows slightly lighter in red colour. CCC prepared using Jaggery shows bark red colour.
Texture	The texture of AAA (Sugar variation) is chewy and hard to tear; BBB (Honey variation) is moister and too soft; CCC (Jaggery variation) is moist and soft enough as candy.
Drying	The Candy Sheets were dried in Microwave Oven at 100 degree Celsius for 40 minutes on one side and 10 minutes on the backside.

Sensory evaluation was done for two sets of developed products. At first sensory evaluation done for products developed using three sweeteners. From the sensory result the two products scored higher had been finalized and undergo for

preparation of products using different variations of vegetable proportion and also the two sweeteners like honey and Jaggery proportions also.

This sensory result showed that the Healthy Vegetable Candy Sheet prepared using Jaggery scored higher followed by honey and sugar. The sample (CCC) Jaggery scored 236 as higher score followed by sample (BBB) Honey scored as 161 and sample (AAA) Sugar scored as 105. These scores were collected from ten semi trained panel members of Avinashilingam Institute of Home Science and Higher Education for Women, Coimbatore.

The scores obtained had evidently showed that the sample prepared using Jaggery has a higher acceptability score than the other two sample prepared using Honey and Sugar. Hence the sheets prepared using Jaggery has been finalized for the standardization of developed Healthy Vegetable Candy Sheet. This Sensory had been carried out to choose the suitable sweetener to prepare the Vegetable Candy Sheet.

Figure 10: Sensory evaluation of Candy Sheets prepared by addition of ten grams of Sugar / Honey / Jaggery

CHART 1

Development of Vegetable Candy Sheets using three sweeteners

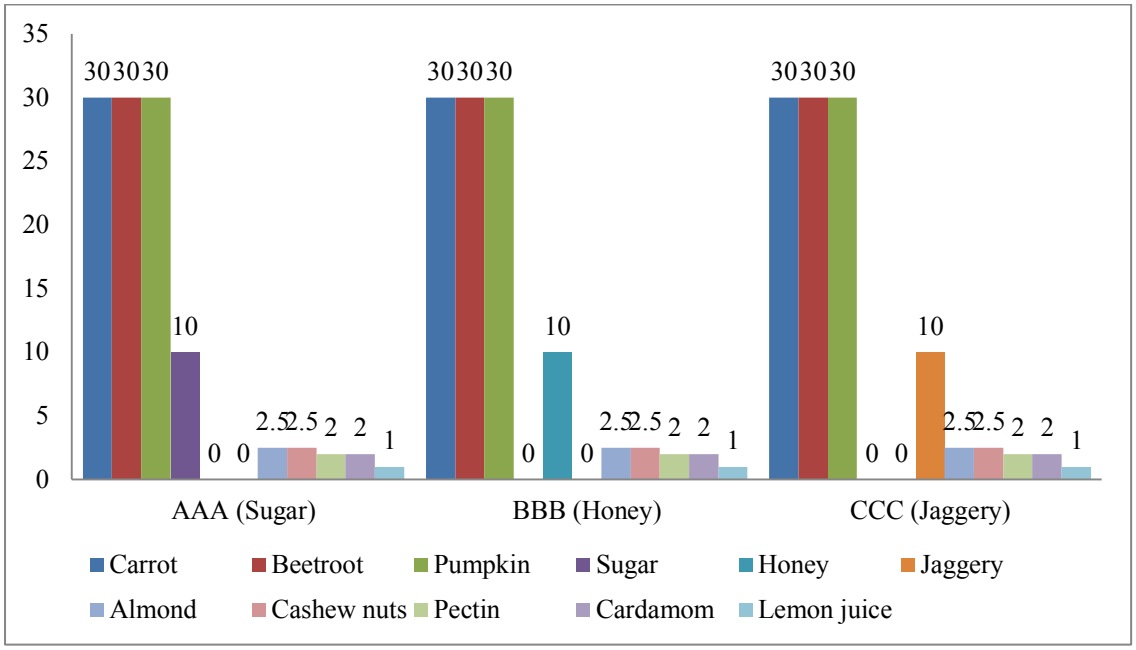


TABLE 14

Mean score for the three variations of sweeteners used in the Vegetable Candy Sheet preparation

N = 10 Semi-Trained Panel Members

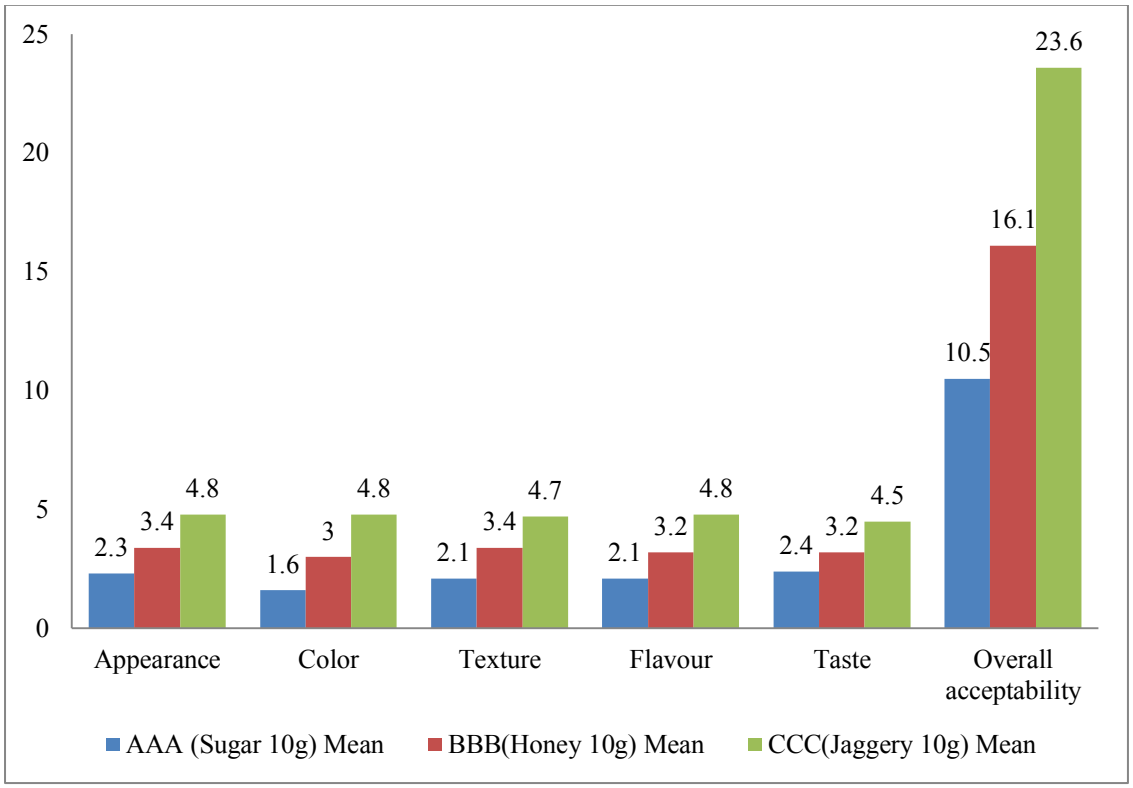
Samples	Appearance	Color	Texture	Flavour	Taste	Overall Acceptability
AAA (Sugar 10g)	2.3 ± 0.48	1.6 ± 0.69	2.1 ± 0.56	2.1 ± 0.56	2.4 ± 0.51	10.5 ± 0.52
BBB (Honey 10g)	3.4 ± 0.69	3.0 ± 0.66	3.4 ± 0.51	3.2 ± 0.42	3.2 ± 0.42	16.1 ± 0.73
CCC (Jaggery 10g)	4.8 ± 0.42	4.8 ± 0.42	4.7 ± 0.48	4.8 ± 0.42	4.5 ± 0.52	23.6 ± 0.84

From the above table it shows that, the sample (AAA) sugar scored lower in all the criteria as Appearance (2.3 ± 0.48); Colour (1.6 ± 0.69); Texture (2.1 ± 0.56); Flavour (2.1 ± 0.31); Taste (2.4 ± 0.51) and overall acceptability (10.5 ± 0.52). The sample (BBB) Honey scored higher than the sample (AAA) in all criteria as Appearance (3.4 ± 0.69); Colour (3.0 ± 0.66); Texture (3.4 ± 0.51); Flavour (3.2 ± 0.42); Taste (3.2 ± 0.42) and Overall Acceptability (16.1 ± 0.73). The sample (CCC) Jaggery scored higher than both (BBB) Honey and (AAA) Sugar sample in all the

criteria as Appearance (4.8 ± 0.42); Colour (4.8 ± 0.42); Texture (4.7 ± 0.48); Flavour (4.8 ± 0.42): Taste (4.5 ± 0.52) and Overall Acceptability (23.6 ± 0.84).

CHART 2

Mean score for the three variations of sweeteners used in the Vegetable Candy Sheet preparation



This sensory evaluation score analysis shows that sample (CCC) had scored higher than two (BBB) and (AAA) samples. From this the two samples scored higher has been chosen for variation formulation. Hence the sample (CCC) and sample (BBB) had been selected for the formulation of variation using Honey and Jaggery.

TABLE 15

Variations of Healthy Vegetable Candy Sheet for Underweight Children

Ingredients	Variations							
	Variation 1 (ABC1)	Variation 2 (ABC2)	Variation 3 (ABC3)	Variation 4 (ABC4)	Variation 5 (ABC5)	Variation 6 (ABC6)	Variation 7 (ABC7)	Variation 8 (ABC8)
	1:1:1	2:0.5:0.5	0.5:2:0.5	0.5:0.5:2	1:1:1	2:0.5:0.5	0.5:2:0.5	0.5:0.5:2
	With Honey (in grams)				With Jaggery (in grams)			
Carrot	30	60	15	15	30	30	15	15
Beetroot	30	15	60	15	30	15	60	15
Pumpkin	30	15	15	60	30	15	15	30
Sugar/ Jaggery	10	10	10	10	10	10	10	10
Almond	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Cashew nut	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Pectin	2	2	2	2	2	2	2	2
Citric acid	1	1	1	1	1	1	1	1
Cardamom	2	2	2	2	2	2	2	2

CHART 3

Variations of the Vegetable Candy Sheets with Honey

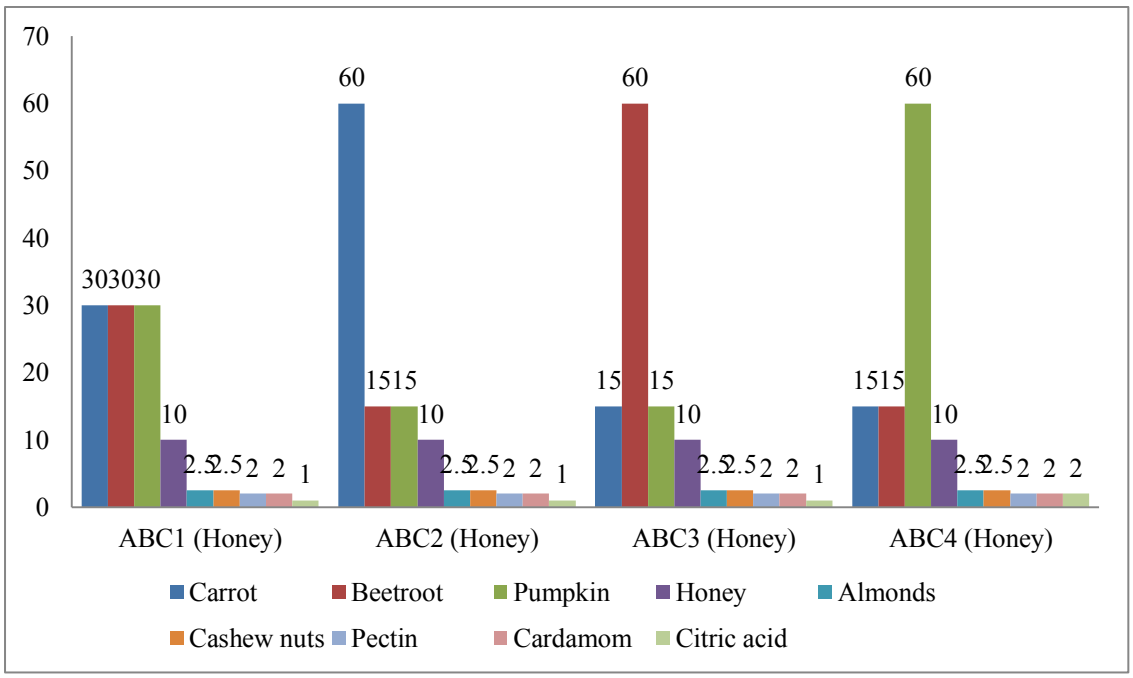
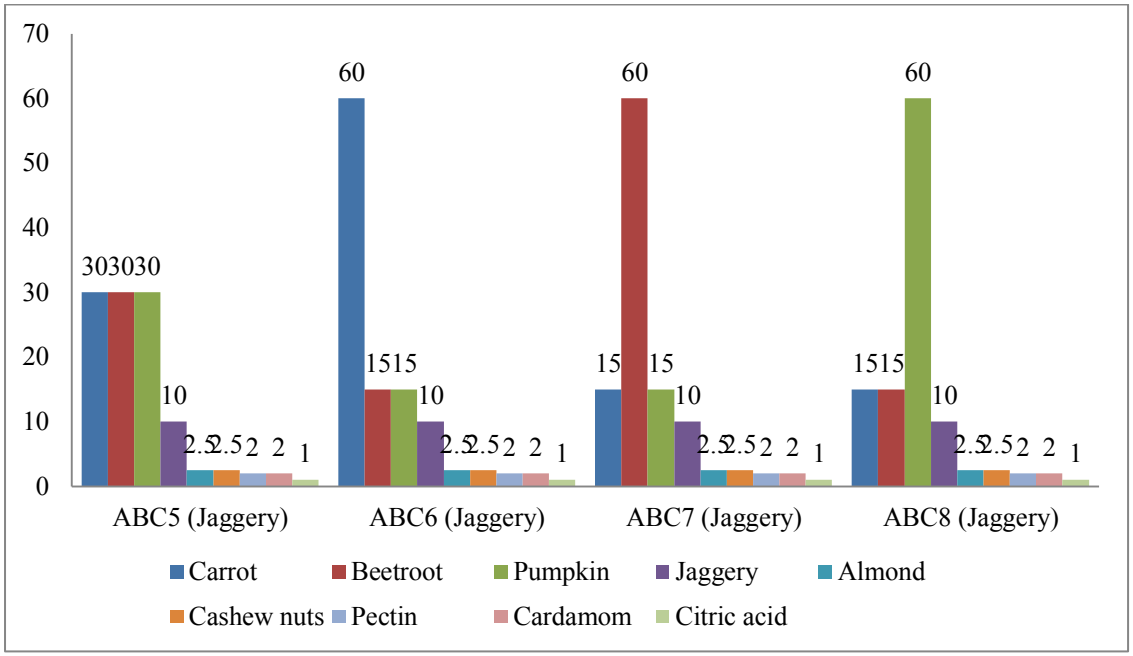


CHART 4

Variations of the Vegetable Candy Sheets with Jaggery



The second set of sensory evaluation of the healthy vegetable candy sheets were carried out with the variations in the quantity of the vegetables chosen and the two sweeteners like Honey and Jaggery were also included from the previous result of sensory evaluation.

In this second set of sensory evaluation eight variations had been developed. The variations had been named as ABC1, ABC2, ABC3, ABC4, ABC5, ABC6, ABC7 and ABC8. From these eight variations four had been developed by the addition of Honey they are ABC1, ABC2, ABC3, ABC4 and another four had been developed by the addition of Jaggery are ABC5, ABC6, ABC7, ABC8.

In the Honey variations the ratio of quantity of vegetable selection had been varied from one variation to another. In four variations the quantity of Carrot: Beetroot: Pumpkin ratio has varied. In ABC1 variation the ratio were 1:1:1; ABC2 were 2:0.5:0.5; ABC3 were 0.5:2:0.5; ABC4 were 0.5:0.5:2.

In the Jaggery variations also the ratio of quantity of vegetables selection had been varied from one variation to another. In four variations the quantity of Carrot: Beetroot: Pumpkin ratio has varied. In ABC5 variation the ratio were 1:1:1; ABC6 were 2:0.5:0.5; ABC7 were 0.5:2:0.5; ABC8 were 0.5:0.5:2.

Five points hedonic scale have been used to evaluate these eight variations. The ten Semi-Trained Panel members were selected from Avinashilingam Institute of Home science and Higher Education for Women, Coimbatore. The sensory result obtained for these eight variations had been listed below:

TABLE 16

Mean sensory acceptability score of eight variations of Developed Healthy Vegetable Candy Sheets

N= 10 Semi - Trained Panel Members

Variations	Appearance (5)	Color (5)	Texture (5)	Flavour (5)	Taste (5)	Overall Acceptability
ABC1	4.4 ± 0.52	4.4 ± 0.52	4.4 ± 0.52	4.2 ± 0.42	4.2 ± 0.42	21.6 ± 0.52
ABC2	3.1 ± 0.56	2.4 ± 0.52	3 ± 0.82	2.6 ± 0.70	2.4 ± 0.84	13.5 ± 0.70
ABC3	2.9 ± 0.99	3.2 ± 0.42	1.7 ± 0.67	2.1 ± 0.32	2 ± 0.67	11.9 ± 0.73
ABC4	2.4 ± 0.57	2.2 ± 0.63	3.2 ± 0.42	3.2 ± 0.42	2.3 ± 0.48	13.3 ± 0.82
ABC5	4.7 ± 0.48	4.7 ± 0.48	4.8 ± 0.42	4.7 ± 0.48	4.8 ± 0.42	23.7 ± 0.48
ABC6	2.9 ± 0.73	2.6 ± 0.70	2.8 ± 0.63	2.7 ± 0.48	2.7 ± 0.48	13.7 ± 0.48
ABC7	1.7 ± 0.48	1.6 ± 0.51	2.8 ± 0.42	3.6 ± 0.52	2.9 ± 0.73	12.6 ± 0.84
ABC8	2.7 ± 0.48	2.5 ± 0.70	2.6 ± 0.84	3.8 ± 0.42	3.6 ± 0.52	15.2 ± 0.92

The second set of sensory evaluation had carried out for the developed eight variations of Vegetable Candy Sheets. The result obtained from the second set of sensory evaluation showed that the variation 5 (ABC5) scored higher among other seven variations.

The table showed that the variation 1 (ABC1) scored in Appearance as (4.4 ± 0.52), Color (4.4 ± 0.52), Texture (4.4 ± 0.52), Flavour (4.2 ± 0.42), Taste (4.2 ± 0.42) and Overall acceptability (21.6 ± 0.52); Variation 2 (ABC2) scored in Appearance as (3.1 ± 0.56), Color (2.4 ± 0.52), Texture (3 ± 0.82), Flavour (2.6 ± 0.70), Taste (2.4 ± 0.84) and Overall acceptability (13.5 ± 0.70); Variation 3 (ABC3) scored in Appearance (2.9 ± 0.99), Color (3.2 ± 0.42), Texture (1.7 ± 0.67), Flavour (2.1 ± 0.32), Taste (2 ± 0.67) and Overall acceptability (11.9 ± 0.73); Variation 4 (ABC4) scored in Appearance (2.4 ± 0.57), Colour (2.2 ± 0.63), Texture (3.2 ± 0.42), Flavour (3.2 ± 0.42), Taste (2.3 ± 0.48) and Overall acceptability (13.3 ± 0.82); Variation 5 (ABC5) scored in Appearance (4.7 ± 0.48), Color (4.7 ± 0.48),

Texture (4.8 ± 0.42), Flavour (4.7 ± 0.48), Taste (4.8 ± 0.42) and Overall acceptability (23.7 ± 0.48); Variation 6 (ABC6) scored in Appearance (2.9 ± 0.73), Color (2.6 ± 0.70), Texture (2.8 ± 0.63), Flavour (2.7 ± 0.48), Taste (2.7 ± 0.48) and Overall acceptability (13.7 ± 0.48); Variation 7 (ABC7) scored in Appearance (1.7 ± 0.48), Color (1.6 ± 0.51), Texture (2.8 ± 0.42), Flavour (3.6 ± 0.52), Taste (2.9 ± 0.73) and Overall acceptability (12.6 ± 0.84); and Variation 8 (ABC8) scored in Appearance (2.7 ± 0.48), Color (2.5 ± 0.70), Texture (2.6 ± 0.84), Flavour (3.8 ± 0.42), Taste (3.6 ± 0.52) and Overall acceptability (15.2 ± 0.92)

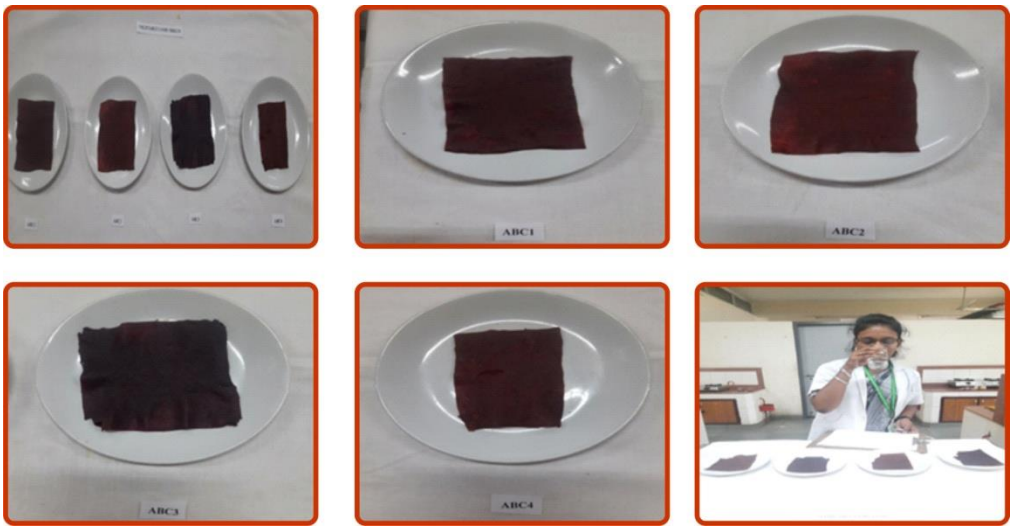


Figure 11: Sensory Evaluation of Candy Sheets prepared with Honey

Figure 12 : Sensory Evaluation of Candy Sheets prepared with Jaggery

From these two sets of sensory evaluation the variation 5 (ABC5) scored higher than the other seven variations of Developed Vegetable Candy Sheets. The

variations developed from the two sweeteners like Honey and Jaggery. The Variations developed from the addition of Jaggery variation has been scored higher. Thus, the Overall acceptability for the Developed Vegetable Candy Sheet was higher in Variation 5 (ABC5) and finalized as the final product.

Large portion size:

After finalizing the final product a large portion of Vegetable Candy Sheets had been prepared and weight the yield to ensure the same amount of yield is obtained when

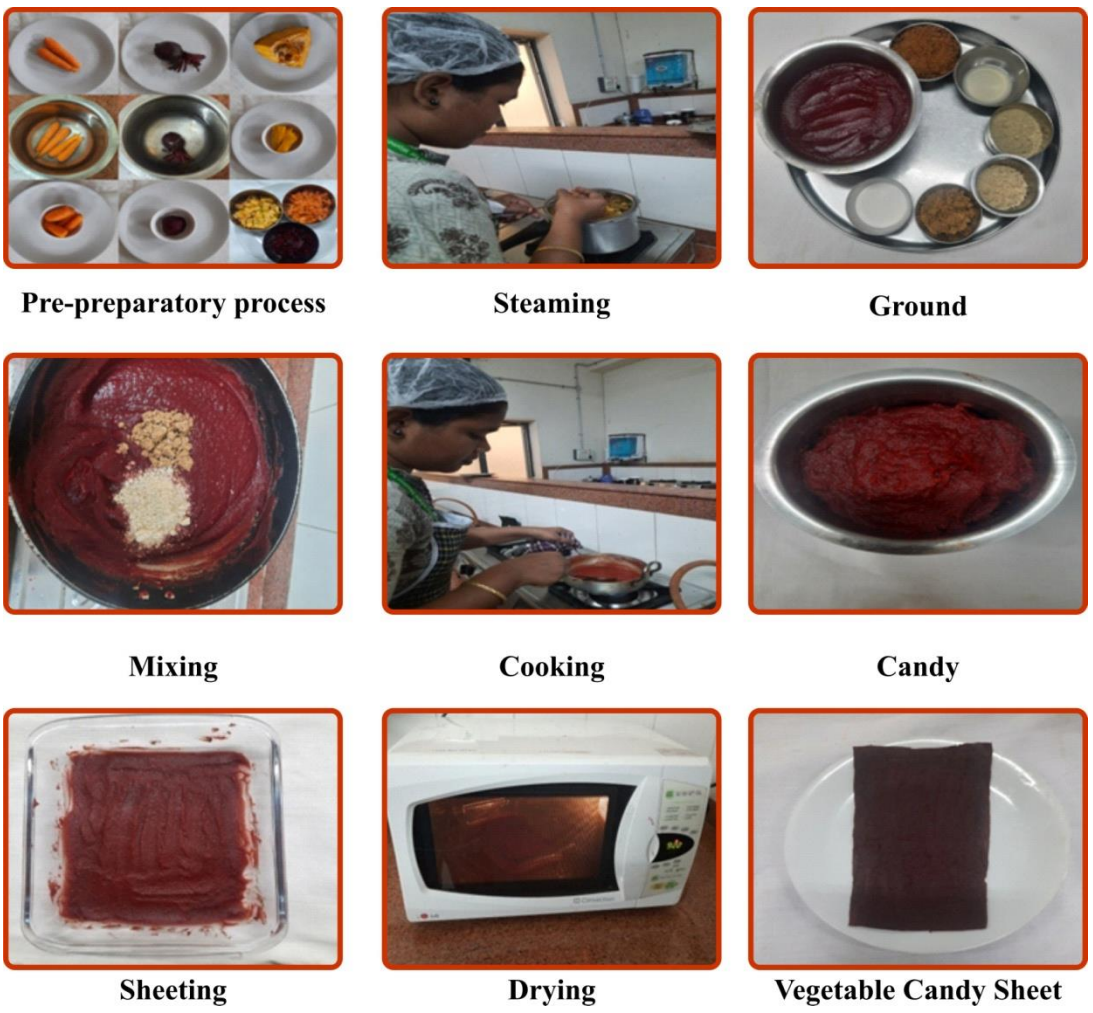


Figure 13: Production of large portion of developed Vegetable Candy Sheets

As a result of large portion preparation a standardized product has been carefully adapted and tested to ensure that it will produce a consistent product every time it is used. The importance of using standardized product has resulted in

consistent food quality, predictable yield, accurate nutrient content, food cost control, efficient purchasing and inventory control.

Standardized product helps to ensure that the best possible food items are produced each time. It is helpful in knowing the ingredients needed to produce the product and also helpful in prevent food waste and shortages. Accurate nutrient content has been obtained by the production of standardized product each time. When the same ingredients and quantities were used each time the product prepared and cost per serving has been remained same. The quantity of ingredients needed for production have been easily calculated based on the information provided on the developed product. Following of standardized product has been helpful in the estimation of food inventory used in the preparation of developed product every time.

Nutrient analysis:

The developed Vegetable candy sheet was given for the nutrient analysis and the nutrient content of major nutrients such as Energy, carbohydrates, protein, fat and fibre are the major nutrients. The minor nutrients such as beta carotene, iron, vitamin C and folic acid also been analyzed. The nutrient content was analyzed according to the nutrients which are prominent in the selected vegetables.

TABLE 17

Nutrient composition of the Developed Vegetable Candy Sheet

S.No	Nutrients	Result
1.	Energy	38.29 kcal
2.	Carbohydrate	6.96g
3.	Protein	0.213g
4.	Fat	1.027g
5.	Fibre	0.273g
6.	Beta carotene	1.164mg
7.	Folic acid	29.68mcg
8.	Iron	0.018mg
9.	Vitamin C	0.7665mg

The above table shows that, the amount of energy present in 15g of the sample is 38.2kcal, 6.8g carbohydrates, 0.2g protein, 1.02g fat, 0.27g fibre, 1.16mg beta carotene, 29.6mcg folic acid, 0.018mg iron and 0.76mg vitamin C.

The sample Variation 5 (ABC5) got the highest mean score and acceptability and hence it is taken for nutrient analysis.

Shelf life analysis:

The developed and dried Vegetable Candy Sheet was analyzed for shelf-life. The 15g of the developed Vegetable Candy Sheet which was fully developed was kept in an air-tight packaging. The packets were first washed thoroughly and then they were dried without leaving any moisture content. The packets were wiped with clean white cotton cloth to prevent any dust and moisture as these may be invaded as a cause for the spoilage of the product. Then the Developed Vegetable Candy Sheet was added in the dried form and it was made sure that the packets were closed properly. The packets were then kept in a dry place in room temperature. The packets were also kept in a refrigerator to analyze the shelf life of the Developed Vegetable Candy sheets. The shelf life of both room temperature and refrigerator has been compared and analyzed. Direct method has been used to analyze the shelf life of the product.

The Developed Vegetable Candy Sheet was kept in refrigerator for fifteen days and was checked for the shelf life of the product. The shelf life of the product kept in refrigerator was analyzed for 15 days. Each day the packet was opened and checked for the spoilage. Any changes in the colour, flavour and smell were noted. The growth of the mould or microbes was also noted to analyze the shelf-life of the product.

The Developed Vegetable Candy Sheet was kept in room temperature for seven days and was checked for the shelf life of the product. The shelf life of the product kept in dry place at room temperature was analyzed for seven days. Each packet was opened and checked for the spoilage. Any changes in the colour, flavour and smell were noted. The growth of the mould or microbes was also noted to analyze the shelf-life of the product.

TABLE 18

Shelf-life study of the Developed Vegetable Candy Sheet (at Room Temperature)

Date of Observation of Microbial Growth	Appearance	Color	Texture	Flavour	Taste	Overall acceptability
Day 1	X	X	X	X	X	X
Day 2	X	X	X	X	X	X
Day 3	X	X	X	X	X	X
Day 4	Y	Y	Y	Y	Y	Y
Day 5	Y	Y	Y	Y	Y	Y
Day 6	Y	Y	Y	Y	Y	Y
Day 7	Y	Y	Y	Y	Y	Y

X -The product was acceptable with the absence of Microbial Growth
Y - The product was not acceptable with the presence of Microbial Growth

This above table shows that the shelf life of the developed Vegetable Candy Sheet stored at room temperature were best before 3 days from the date of manufacturing. From day three the flavour changes and mould formation starts growing in the Vegetable Candy Sheet. Hence, this result declared that the Vegetable Candy Sheets stored in Room Temperature was acceptable for three days from the date of manufacturing.

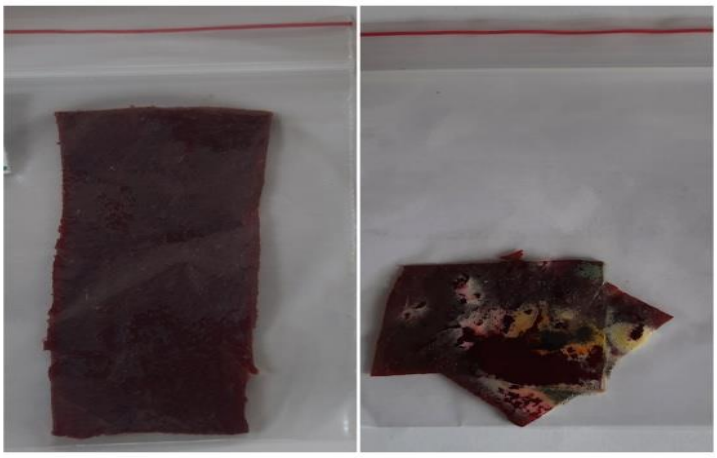


Figure 14: Shelf life analysis at Room Temperature (RT)

TABLE 19

Shelf-life study of the Developed Vegetable Candy Sheet (at Refrigerator)

Date of Observation of Microbial Growth	Appearance	Color	Texture	Flavour	Taste	Overall acceptability
1 to 3	X	X	X	X	X	X
4 to 6	X	X	X	X	X	X
7 to 9	X	X	X	X	X	X
10 to 12	X	X	X	X	X	X
13 to 15	X	X	X	X	X	X
16 to 18	Y	Y	Y	Y	Y	Y

X -The product was acceptable with the absence of Microbial Growth
Y - The product was not acceptable with the presence of Microbial Growth

This above table shows that the shelf life of the developed Vegetable Candy Sheet stored at refrigerator were best before 15 days from the date of manufacturing. From day fifteen the flavour changes and mould formation starts growing in the Vegetable Candy Sheet. Hence, this result declared that the Vegetable Candy Sheets stored in Refrigerator was acceptable for fifteen days from the date of manufacturing the Vegetable Candy Sheets.

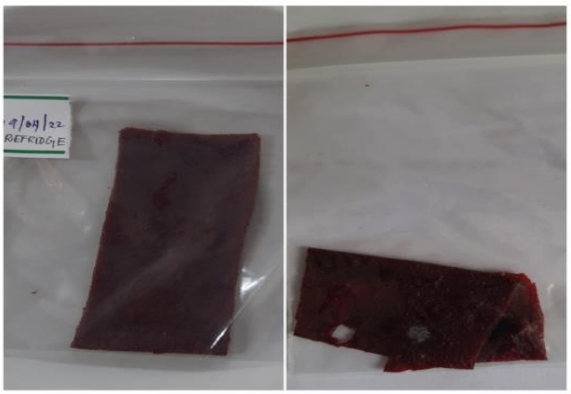


Figure 15: Shelf life analysis for Vegetable Candy Sheets stored at Refrigerator

C. Food Costing, Packaging and Labelling of the Developed Healthy Vegetable Candy Sheets

Food costing is important to know as it has a direct effect on the profit. It is the cost of the ingredients used and does not include other costs. Food costing is an essential tool in determining whether food cost targets are being met.

Recipe costing helps us to know how much food cost is incurred to prepare a candy. This gives us a clear view of how much one can earn on per candy. It plays a significant role in deciding the selling price of the product.

TABLE 20

Food cost of the Vegetable Candy Sheet as per two servings

S.No	Ingredients	2 Servings	Cost per 2 Servings
1	Carrot	30g	0.9
2	Beetroot	30g	1.2
3	Pumpkin	30g	0.9
4	Jaggery	10g	0.6
5	Almonds	2.5g	1.25
6	Cashew nuts	2.5g	0.75
7	Pectin	2g	1
8	Cardamom	2g	1.6
9	Lemon juice (Citric acid)	1ml	0.5
Total Cost			8.7

Calculation:

Yield - 30g

Weight per portion - 15g

No .of serving - 2

Cost per two portion - 8.7 Rs

Cost per portion = Total cost / Number of Serving X Overhead cost (1.66)

Cost per portion = 8.7 / 2 X 1.66

= 4.35 X 1.66

= 7.22 Rs.

Cost per portion = RS. 7

A large number of polymeric materials, in addition to cellulosics and aluminium foil, are utilised to make candy. Certain applications also call for the usage of paper board and metal containers. Despite the fact that a range of packaging materials are available, the final choice of wrapper is determined by the needed shelf life. Plastic, which is commonly flexible and provides the required protection and preservation, grease resistance, physical strength, castability, and printability, is the most popular choice of packaging material. As a result of their reduced weight, plastics are the chosen material for candy packaging.

Candy packaging is always evolving. Plastic films and their laminates are gradually replacing waxed papers leading to enhanced performance, whereas aluminium foil laminates are replacing waxed papers terms of cost reduction and improved flex crack resistance.

During distribution, storage, and sales, a package for sugar and chocolate sweets must satisfy a variety of roles. Essentially, the packaging must safeguard the product's quality qualities against chemical and microbial deterioration. The key functional packaging needs for sugar candies and chocolates are protection from dust, dirt, and other contaminating agents, moisture / water vapours pickup or loss resulting in sugar and fat bloom, stickiness, hardness, desiccation, rancidity owing to interaction with moisture and oxygen, colour and scent loss and tainting, and physical damages such as dusting, breaking, and loss of form.

Figure 16: Packaging of Vegetable Candy Sheets for Underweight Children

Part VII of the Prevention of Food Adulteration (PFA) Rules, 1955, and the Standards of Weights and Measures (Packaged Commodities) Rules, 1977, specify that labels for packaged food goods must have the following information: a name, a brand name, or a brief description; In descending order of their composition by

weight or volume, the names of the ingredients used in the product; Name and complete address of the producer / packer, the importer, and the country of origin of the imported product (if the food item is made outside of India but packaged in India); Nutritional information; food additives, colours, and flavours information; use instructions; Symbol for vegetarians or non-vegetarians; Distinctive batch, lot, or code number; Net weight, quantity, or volume of contents; Date, month, and year, Month and year of manufacture and packaging; Month and year by which the product is best consumed; Maximum retail price.

All declarations may be printed in English or Hindi on a label securely fastened to the box, or on a supplementary wrapper holding the imported item, or printed on the package itself, or on a card or tape firmly adhered to the package and bearing the relevant information prior to consumer approval.

According to the FSS Packaging and Labelling Regulation 2011, "Prepackaged" or "Pre-packed food," including multi-piece packaging, must be labelled with necessary information. As a result, obligatory labelling has been added in the created Vegetable Candy Sheet.

Figure 17 : Labelling the developed Vegetable Candy Sheet

D. Acceptability of the Developed Healthy Vegetable Candy Sheets among selected School going Children

The finally developed Vegetable Candy Sheet was undergone sensory evaluation among the 50 selected School Going Children. The acceptability rate of Vegetable Candy Sheet had been analyzed by doing sensory evaluation. The score has been given based on the five point hedonic scale. Hence, the percentage of acceptability among the children has been analyzed by doing mean and standard deviation for the obtained score. The attributes that are analyzed in this sensory evaluation are Appearance, Color, Texture, flavour, Taste and Overall acceptability.

TABLE 21

Mean score for sensory evaluation of acceptability among School going Children

Code	Appearance	Color	Texture	Flavour	Taste	Overall acceptability
ABC5	3.4 ± 0.58	4 ± 0.95	3.1 ± 0.32	3.7 ± 0.67	3.5 ± 0.70	17.7 ± 0.95

The above mean score for sensory evaluation of acceptability among 50 School Going Children resulted that the acceptability scores for appearance (3.4 ± 0.58); Color (4 ± 0.95); Texture (3.1 ± 0.32); Flavour (3.7 ± 0.67); Taste (3.5 ± 0.70) and Overall acceptability (17.7 ± 0.95).

The percentage of acceptability among School Going Children for the development of Vegetable Candy Sheets were resulted that 68 per cent likes appearance; 80 per cent likes Color; 62 per cent likes Texture; 74 per cent likes Flavour; 70 per cent likes Taste and 70.8 per cent likes overall acceptability.

The result obtained from the sensory acceptability score has showed the 70.8 per cent of acceptability has been provided by the 50 selected School Going Children for the developed Vegetable Candy Sheet.

CHART 5

Mean score on sensory evaluation of acceptability for Developed Vegetable Candy Sheet among School going Children

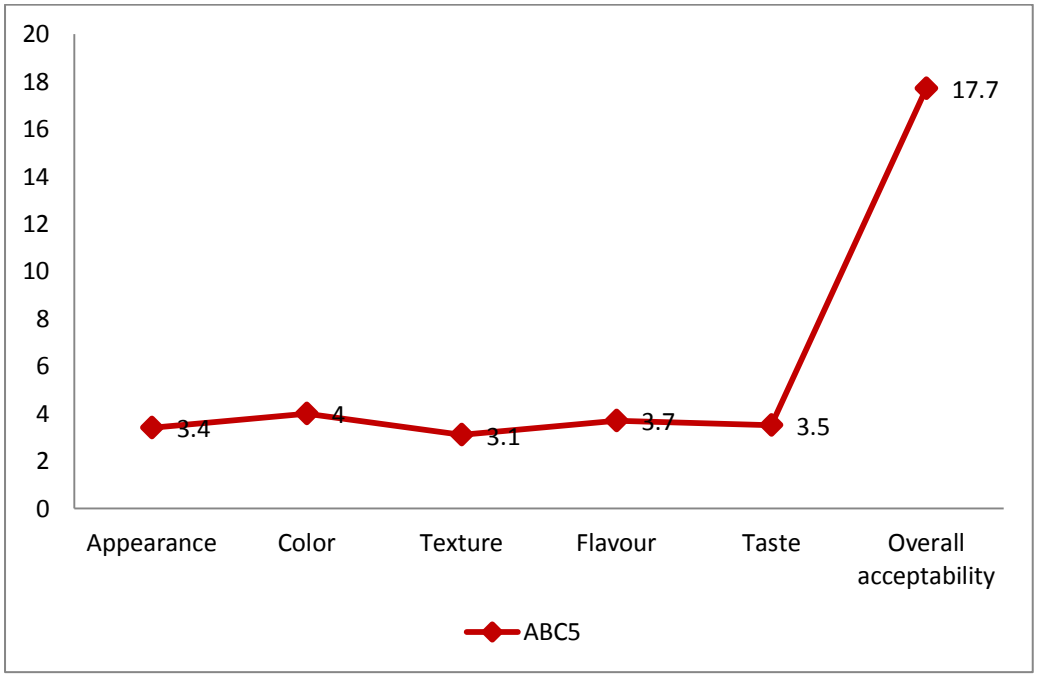


Fig 18: Sensory Evaluation of Candy Sheets among School Going Children

V. SUMMARY AND CONCLUSION

Preschool stage is the most crucial period among children. Eating habits, food preferences and physical activity behavior are the characteristics which had their effects on the later stages of childhood and carried to adulthood also. The intake of fruits and vegetables play an important role in children's growth and development as improving the health status, strengthening of immune system and providing protection against diseases. The consumption of seven to eight servings of fruits and vegetables per day were reducing the risk of depression and anxiety.

According to the large study conducted in ten European countries among the people consume fruits and vegetables resulted in longer life. Globally, about 80 per cent of total Undernourished children were living in 20 countries. In India almost 60 million children were undernourished. To prevent children being malnourished from their inappropriate nutritional status the World Health Organization (WHO), The World Food Programme and UNICEF had suggested of giving a Ready-to-Use Therapeutic Foods (RUTF) which has been prepared in home itself. Hence the study titled **"Development of Healthy Vegetable Candy Sheets for Underweight Children"** was undertaken with the following objectives, to develop value added Healthy Vegetable Candy Sheet using Carrot, Beetroot and Pumpkin, to analyze nutritional composition, sensory evaluation and shelf life analysis of the Healthy Vegetable Candy Sheets and to study the acceptability of the Healthy Vegetable Candy Sheets among School Going Underweight Children.

The methodology comprised Selection of Ingredients was purchased in the local market. The production process of Vegetable Candy Sheets was developed. Seven trials were carried out to standardize the Vegetable Candy Sheet. Organoleptic evaluation were undertaken by 25 semi trained - panelists from Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore. They were asked to evaluate the quality attributes such as appearance, colour, texture, flavour and taste of Vegetable Candy Sheet. The finalized product had been prepared for large portion size of ten. Nutrient analysis such as Energy, Carbohydrate, Protein, Fat, Fibre, Iron, Beta carotene, Folic acid and Vitamin C were done by AOAC method for Vegetable Candy Sheet. Shelf life analysis of the developed product was done to find the palatability period for human consumption.

Food costing was done for the developed Vegetable Candy Sheet. Labelling had been designed for packaging the Developed Vegetable Candy Sheet. Finally sensory evaluation for developed Vegetable Candy Sheet was done among 50 School going Children to find the overall acceptability.

The Salient findings of the study are:

- The development of Healthy Vegetable Candy Sheet for Underweight children was act as a healthy snack option for Children and children usually have craving for sweets. Hence, the Candy sheets were developed to meet the sweet craving along with the nutritional benefits essential for Underweight children.
- The processing of vegetable candy sheets were selection of ingredients from local market, washing, peeling, cutting, weighing the major and minor ingredients, steaming, grounding, cooking, sheeting, drying, packaging and storing.
- The Vegetable Candy Sheet was developed by doing seven trials. From the seven trials the Vegetable Candy Sheet preparation method has been finalized. The quality and quantity of ingredients selected, cooking time, yield, selection of drying equipment, drying temperature finalization had been carried out in the trials of development of Vegetable Candy Sheet.
- In the first trial the Vegetable Candy sheets were prepared without the addition of sugar, pectin and cardamom. The prepared sheets were sticking to the mould. The temperature required to dry the sheets were increased about one and half hour.
- In the second trial the Vegetable Candy Sheets were prepared without the addition of pectin. The sheets were formed but it is too thin in texture and not obtained in the required consistency.
- In the third trial the Vegetable Candy Sheets were prepared with the addition of pectin. The prepared sheets were thick. Hence, this trial attains the required thickness for the Vegetable Candy Sheet sheeting process.
- In the fourth trial the Vegetable Candy Sheets were prepared as jam like consistency and dried into sheets. Due to the jam like consistency the sheets were cracked and not in the required texture.

- In the fifth trial the candy sheets were dried using Oven Toaster Griller (OTG) to check the temperature required for drying and also to compare texture of Vegetable Candy Sheet dried using microwave oven. Hence, the Vegetable Candy Sheets were dried at 150º Celsius for 20 minutes.
- In the sixth trial the Vegetable Candy Sheets were prepared using Oven / Toaster/ Griller (OTG) and Microwave Oven. The comparison of prepared Vegetable Candy Sheets was carried out. The drying equipment used for drying and temperature required for drying the sheets has been finalized.
- Further the last trial which was prepared using three sweeteners has been undergone for sensory evaluation and finalized the two products which are scored higher. Hence the Vegetable Candy Sheet developed using Jaggery scored higher followed by Honey and Sugar. For the formulation of variations Jaggery and Honey sweetener has been selected.
- In each sweetener four variations had been formulated and coded as ABC1, ABC2, ABC3, ABC4 as Honey variations and ABC5, ABC6, ABC7, ABC8 as Jaggery Variations. The sensory evaluation had been carried out for the Variations formulated using both Honey and Jaggery sweeteners. The Overall acceptability for variation code ABC5 scored higher and finalized as a final product. This contained 30 grams of carrot, 30 grams of beetroot, 30 grams of pumpkin, 10 grams of jaggery, 2.5 grams of almonds, 2.5 grams of cashew nuts, 2 grams of pectin, 2 grams of cardamom and 1 gram of citric acid.
- The finalized product has been prepared for three times to standardize the developed product. Hence, Vegetable Candy Sheets were repeated to record the preparation, production details such as proportion of Ingredients, equipments, cooking time, method of preparation, yield and portion size. After the product is standardized the candy sheets had been prepared in large portion size to get the accurate yield of Candy Sheets. This large portion size was helpful in determining the ingredients needed, cooking time, reduce the wastage of resources.
- The developed product was then undergoing for nutritional analysis by using AOAC procedure. The nutritional analysis of the 15grams (per serving) of sample possessed 38 kcal of Energy, 6.8 g carbohydrates, 0.2 g protein, 1.02

g fat, 0.27 g fibre, 1.16 mg beta carotene, 29.6 mcg folic acid, 0.018 mg iron and 0.76 mg Vitamin C.

- The shelf-life analysis for the developed Vegetable Candy Sheet had been done by using direct method. The Candy Sheets were packed in the sterilized air-tight packets and stored in both Room Temperature (RT) and Refrigerator.
- In Room Temperature (RT) the Candy Sheets are best before three days from the date of manufacturing. In Refrigerator, the Candy Sheets are best before fifteen days from the date of manufacturing. In the shelf life analysis daily the air-tight packets has been opened and evaluated for Appearance, Colour, Texture, Flavour, Taste and also the visible microbial growth in the Developed Vegetable Candy Sheets.
- Food cost, is a pricing method to determine the selling price of the developed Vegetable Candy Sheets. The cost per portion of the Candy sheet weighed 15 grams was priced Rs.7. The label designing was done for the developed Vegetable Candy Sheets. The high-density polyethylene packages were selected to pack the developed product. The mandatory information has been included in the labeling of the Developed Vegetable Candy Sheet.
- Finally the acceptability among 50 school going children has been analyzed by doing sensory evaluation for the attributes like Appearance, Color, Texture, Flavour and Taste of the Developed Vegetable Candy Sheet. The sensory result shows that 70 per cent of overall acceptability from the selected 50 School going Children for the Developed Vegetable Candy Sheet.

Conclusion:

The developed Vegetable Candy Sheets would certainly serve as a healthy snack for the Underweight Children. Younger population groups especially Preschool children lack consumption of balanced diet especially deficit for macronutrients and as well micronutrients. Formulation of products with combination of vegetables, fruits and nuts with natural sweeteners such as honey will promote healthy eating pattern and motivate children to consume the products

with joy. Encouraging children to use such combination will provoke behavioural changes with healthier choices for foods.

Scope for Future Research Work:

- Development of Vegetable Candy Sheets using single vegetable and assess their acceptability among children.
- Supplementation and evaluation of the Vegetable Candy Sheets among School Going Underweight Children.
- Development of Vegetable Candy Sheet using natural sweeteners for Diabetic patients.

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ANNEXURE I

Sensory score card of Vegetable Candy Sheets prepared using three sweeteners

Name :

Date:

You are requested to rate the given product for appearance, colour, texture, flavour and taste.

Code	Appearance	Colour	Texture	Flavour	Taste	Over all acceptability
AAA						
BBB						
CCC						

Scores

Appearance : 5 - Smoothy layer; 4 - Good; 3 - Average; 2 - Irregular layer; 1 - Very irregular layer.

Colour : 5 - Bright and colourful; 4 - Good; 3 - Average; 2 - Dull; 1 - Very dull.

Texture : 5 - Thicker; 4 - Good; 3 - Average; 2 - Slightly thicker; 1 - Very thinner.

Flavour : 5 - Excellent flavour; 4 - Good flavour; 3 - Moderate flavour; 2 - Unpleasant flavour; 1 - Very unpleasant flavour.

Taste : 5 - Sweeter; 4 - Moderately sweeter; 3 - Slightly sweeter; 2 - Less sweeter; 1 - Very less sweeter.

ANNEXURE II

Sensory score card of Vegetable Candy Sheets with Honey and Jaggery variations

Name :

Date:

You are requested to rate the given product for appearance, colour, texture, flavour and taste.

Code	Appearance	Colour	Texture	Flavour	Taste	Over all acceptability
ABC1						
ABC2						
ABC3						
ABC4						
ABC5						
ABC6						
ABC7						
ABC8						

Scores

Appearance : 5 - Smoothy layer; 4 - Good; 3 - Average; 2 - Irregular layer; 1 - Very irregular layer.

Colour : 5 - Bright and colourful; 4 - Good; 3 - Average; 2 - Dull; 1 - Very dull.

Texture : 5 - Thicker; 4 - Good; 3 - Average; 2 - Slightly thicker; 1 - Very thinner.

Flavour : 5 - Excellent flavour; 4 - Good flavour; 3 - Moderate flavour; 2 - Unpleasant flavour; 1 - Very unpleasant flavour.

Taste : 5 - Sweeter; 4 - Moderately sweeter; 3 - Slightly sweeter; 2 - Less sweeter; 1 - Very less sweeter.

ANNEXURE III

Sensory score card of Vegetable Candy Sheets on acceptability among School going Children

Name :

Date:

You are requested to rate the given product for appearance, colour, texture, flavour and taste.

Code	Appearance	Colour	Texture	Flavour	Taste	Over all acceptability
ABC5						

Scores

Appearance : 5 - Smoothy layer; 4 - Good; 3 - Average; 2 - Irregular layer; 1 - Very irregular layer.

Colour : 5 - Bright and colourful; 4 - Good; 3 - Average; 2 - Dull; 1 - Very dull.

Texture : 5 - Thicker; 4 - Good; 3 - Average; 2 - Slightly thicker; 1 - Very thinner.

Flavour : 5 - Excellent flavour; 4 - Good flavour; 3 - Moderate flavour; 2 - Unpleasant flavour; 1 - Very unpleasant flavour.

Taste : 5 - Sweeter; 4 - Moderately sweeter; 3 - Slightly sweeter; 2 - Less sweeter; 1 - Very less sweeter.

APPENDIX I

Institutional Human Ethics Committee Approval Form

INSTITUTIONAL HUMAN ETHICS COMMITTEE

Avinashilingam

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

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

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

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

26th Febraury 2022

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

Dear K.Lavaniya,

Ref: Your proposal No. IHEC/21-22/FSMD-14 entitled "Development of Healthy Vegetable Candy Sheets for Underweight Children" 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-14 entitled "Development of Healthy Vegetable Candy Sheets for Underweight Children" submitted by you. The Approval number for the same is AUW/IHEC/FSMD-21-22/XPD-14.

We wish you all the best in your research endeavours.

Regards,

S. Uma Mageshwari

Dr.S.Uma Mageshwari
Member Secretary

Institutional Human Ethics Committee

APPENDIX II

Plagiarism Report

Development of healthy vegetbale candy sheets foe underweight children

ORIGINALITY REPORT

9%	6%	3%	5%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	www.tarj.in Internet Source	1%
2	fmtmagazine.in Internet Source	1%
3	Submitted to University of North Carolina, Greensboro Student Paper	1%
4	niftem.ac.in Internet Source	1%
5	Submitted to University of Wales Institute, Cardiff Student Paper	<1%
6	dphhs.mt.gov Internet Source	<1%
7	www.ejmanager.com Internet Source	<1%
8	www.lexology.com Internet Source	<1%

APPENDIX III

Nutritional analysis lab report

ALPHA
LABS & TECHNOLOGIES
FOOD / WATER / SOIL TESTING

281-C, Thadagam Road, Amutha Surabi Upstairs,
Opp. Avila Convent, Venkittapuram, Coimbatore-641025.
Tel : 0422 - 2441499 Mobile: 96294 40642
E-mail : alphalabtech@gmail.com www.alphalabtech.in

TEST REPORT

REPORT NO:	ALT/17245/2022

REPORT DATE:	13.05.2022

Customer Details :	Ms. LAVANIYA AVINASHILINGAM UNIVERSITY, COIMBATORE.		
Sample Description:	VEGETABLE CANDY SHEET		
Sample Code no:	ALT/APR/22/17245	Sample Received Date	28.04.2022
Sample Analysis Date	28.04.2022	Sample Completed Date	13.05.2022

RESULTS OF THE ANALYSIS

S.NO	PARAMETERS	UNIT	METHOD	RESULTS
1.	Moisture	%	IS 6287:1985	**42.56**
2.	Ash	%	IS 6287:1985	**2.72**
3.	Fat	%	IS 6287:1985	**6.85**
4.	Protein	%	IS 7219:1973	**1.42**
5.	Carbohydrate	%	IS 1656:2007	**46.45**
6.	Energy	Kcal	ALT/SOP/03/01:2016	**255.32**
7.	Fibre	%	IS 12711:1987	**1.82**
8.	Iron	mg/100g	AOAC 21ST EDITION 944.02:2019	**0.12**
9.	Beta Carotene	mg/100g	AOAC Official Method 999.15, 18thEdition	**7.76**
10.	Folic Acid	mcg/100g	AOAC 21ST Edition 974.29	**197.88**
11.	Vitamin C	mg/100g	AOAC Official Method 967.21, 18th Edition	**5.11**

*** End of Report ***

ALPHA LABS & TECHNOLOGIES ISO 9001 CERTIFIED

Authorized Signatory
S.S.Gayathri
Technical Manager

APPENDIX IV

Estimation of Energy

Scope:

The SOP provides the method for determination of Energy value I the products.

Method:

The energy of the food product is analysed by calculation method

Calculation:

Food energy values in both kilocalories (kcal) and kilojoules use the same factors. Energy (kcal/100g) = (Carbohydrate X 4) + (Protein X 4) + (Fat X 9)

APPENDIX V

Estimation of Protein by lowry's method

Protein can be estimated by the methods as given by Lowry and also by estimating the totalnitrogen content. No method is 100% sensitive. Hydrolysing the protein and estimating the amino acids alone will give the exact quantification.. The method developed by Lowry et al (2010), is sensitive enough to give a moderately constant value and hence largerly followed. Protein content of enzyme extracts is usually determined by this method.

Principle:

The blue colour developed by the reduction of the phosphomolybdic - phosphotungastic components in the Folin-ciocalteau reagent by the amino acids tyrosine and tryptophan present in the protein plus the colour developed by the biuret reaction of the protein with the alkaline cuprictartrate are measured in the Lowry's method.

Materials:

- 2% sodium Carbonate in 0.1 N Sodium Hydroxide (Reagent)

- 0.5% Copper Sulphate, (CUSO4 5H20) in 1% potassium sodium tartrate (Reagent B)
- Alkaline copper solution: Mix 50 mL of A and 1 mL of B prior to use (Reagent C)
- Folin-ciocalteau reagent (reagent D); Reflux gently for 10 hours a mixture consisting of 100 g sodium tungstate (Na2WoO4 2H20), 25 g sodium molybdate (Na2MoO4 2H20)
- 700 mL water, 50 mL of 85% phosphoric acid, and 100 mL of concentrated hydrochloric acid in a 1.5 L flask. Add 150 g llithium sulphate, 50 mL water and a few drops of bromine water. Boil the mixture for 15 min without condenser to remove excess bromine cool, dilute to 1 L and filter. The reagent should have no greenish tint. (determine the acid concentration of the reagent by titration with 1 N NAOH to a phenolphthalein end point)
- Protein solution (Stock standard) Weigh accurately 50 mg of bovine serum albumin (Fraction V) and dissolve in distilled water and make up to 50 mL in a standard flask.

Working standard

Dilute 10 mL of the stock solution to 50 mL with distillued water in a standard flask. One mL of this solution contains 200 µg protein.

Procedure

- Extraction of protein from sample extraction is usually carried out with buffers used for the enzyme assay.

- Weigh 500mg of the sample and grind well with a pestle and mortar in 5 - 10 ml of the buffer. Centrifuge and use the supernatant for protein estimation.

Estimation of protein

- Pipette out 0.2, 0.4, 0.6,0.8 and 1ml of the working standard into a series of test tubes.
- Pipette out 0.1ml and 0.2 ml of the sample extract in two other test tubes.
- Make up the volume to 1ml in all the test tubes. A tube with 1ml of water
- serves as the blank.

- Add 5 ml of reagent C to each tube including the blank. Mix well and allow to stand for 10min.
- Then add 0.5ml of reagent D, mix well and incubated at room temperature in
- the dark for 30 min. Blue colour is developed.
- Take the reading at 660nm.
- Draw a standard graph and calculate the amount of protein in the sample.

Calculation

Express the amount of protein mg/g or 100g sample.

APPENDIX VI

Estimation of Crude Fibre

Crude fibre consists largely of cellulose and lignin (97%) plus some mineral matter. It presents only 60-80% of the cellulose and 406% of the lignin. The crude fibre content is commonly used as a measure of the nutritive value of poultry and live stock feeds and also in the analysis of various foods and food products to detect adulteration, quality and quantity.

Principle:

During the acid and subsequent alkali treatment, oxidative hydrolytic degradation of the native cellulose and considerable degradation of lignin occur. The residue obtained after final filtration is weighed, incinerated, cooled and weighed again. The loss in weight gives the crude fibre control.

Materials

Sulphuric acid solution (0.255± 0.005 N): 1.25g concentrated sulphuric acid diluted to 100mL (Concentration must be checked by titration)

Sodium hydroxide solution (0.313± 0.005N): 1.25g sodium hydroxide in 100mL distilled water (Concentration must be checked by titration with standard acid)

Procedure

Extract 2g of ground material with ether or petroleum ether to remove fat (Initial boiling temperature 35-38 ºC and final temperature 52ºC) If fat content is below 1% extraction may be omitted.

After extraction with ether boil 2g of dried material with 200mL of sulphuric acid for 30min with bumping chips.

Filter through muslin and wash with boiling water until washings are no longer acidic

Boil with 200mL of sodium hydroxide solution for 30 min.

Filter through muslin cloth again and wash with 250 mL of boiling 1.25% H2SO4 there 50mL of portions of water and 25mL alcohol.

Remove the residue and transfer to ashing dish (Preweighed dish W1)Dry the residue for 2 h at 130± 2º C. Cool the dish in a desicator and weigh (W2).

Ignite for 30 min at 600± 15ºC.

Cool in a desiccators and reweigh (W3).

Calculation

% crude fibre in ground sample

= Loss in weight on ignition (W2-W1) - (W3-W1) / weight of sample x 100

APPENDIX VII

Ascorbic acid (Vitamin c)

Principle

Ascorbic acid reduces the 2, 6-dichlorophenol indophenols dye to a colourless lecuo-base. The ascorbic acid gets oxidised to dehydroascorbic acid.. Though the dye .is a blue coloured compound, the end point is the appearance of pink colour. The dye is pink coloured in acid medium.Oxalic acid is used as the titrating medium.

Materials:

1. Oxalic acid 4%
2. Dye solution: weigh 42 mg sodium bicarbonate into a small volume of distilled water. Dissolve 52 mg 2, 6-dichloro indophenols in it and make up to 200 ml. With distilled water.
3. Stock standard solution: Dissolve 100mg ascorbic acid in 100mL of 4% oxalic acid solution solution in a standard flask (1mg/mL)
4. Working standard: Dilute 10 mL of the stock solution to 100 mL with 4% oxalic acid. The concentration of working standard is 100µg/mL.

Procedure:

- Pipette out 5mL of the working standard solution into a 100mL conical flask.
- Add 10mL of 4% oxalic acid and titrate against the dye (V1 mL). End point is the Appearance of pink colour which persists for a few minutes. The amount of the dye consumed is equivalent to the amount if ascorbic acid.
- Extract the sample (0.5-5g depending on the sample) in 4% oxalic acid and make up to a known volume (100mL) and centrifuge.
- Pipette out 5mL of this supernatant and 10mL of 4% oxalic acid and titrate against the dye (V2 mL).

Calculation

Amount of ascorbic acid mg/100g sample = 0.5mg x V2x 100mLx100 / V1 mL 5mL Wt. of thesample

APPENDIX VIII

Estimation of Iron

Aim:

To estimate the amount of iron in 100g of the given food sample.

Principle:

The food sample is oxidized with ignition or oxidation. Iron as ferric ferric iron reacts with ammonium thiocyanate or with potassium thiocyanate to give ferric thiocyanate which is red in colour. The colour which is a measure of the concentration is measured colorimetrically.

Apparatus:

Volumetric flask, test tubes, klett, pipette.

Reagents:

1. Stock iron solution: Dissolved 0.0702gm (70.2mg) of reagent grade crystalline ferrous ammonium sulphate (Mohr's salt) in 100 ml of water.
2. Working standard: Prepared a working standard solution in a 100ml volumetric flask by adding 10ml of the stock solution and diluted to the mark with distilled water.
3. Saturated potassium persulphate solution: Shook 7 to 8g of reagent grade potassium per sulphate in 100ml of water in a glass stoppered flask. The undissolved crystals settled to the bottom and compensates the loss by decomposition
4. 3N Potassium thiocyanite: Dissolved 146g of reagent grade potassium thiocyanate in water and diluted to 500 ml in water. Filtered if turbid. Added 20ml of pure acetone to improve the keeping quality. Deterioration will be evident from the rapid fermentation of a yellow colour in the blank. Stored in brown bottles.

Procedure:

- 2g of the sample was ashed by ignition.
- When ashing had been completed 5 ml of hydrochloric acid was added and made up to 100 ml in a volumetric flask.
- Took different aliquots of the standard solution (1ml- 5ml) corresponding to 10-50 gamma in a series of test tubes.
- 2ml of the unknown solution was taken in the test tube.
- Added 1 ml of 30% of H_2SO_4, 1 ml of potassium persulphate and 1.5 ml of potassium thiocyanate to all the test tubes.
- This was made up-to 10 ml with water.
- A blank was prepared by adding the reagents except the standard or the unknown solution.
- Allowed the colour to develop for 20 minutes and the intensity was read 530-540 μ filter in the colorimeter.

Result:

The amount of iron present in 100g of food sample

APPENDIX IX

Estimation of Carbohydrate

Calculation method: 100 minus the values of the moisture, total ash, total fat, total protein. Calculate the result for Carbohydrates.

Carbohydrate (g/100g) = 100 - (Moisture + Ash + Protein + Fat + Fibre

APPENDIX X

Estimation of Fat

To determine the amount of Fat in the product.

Procedure:

- First of all, rinse all the glass apparatus by petroleum ether and dry it in the oven at 102°c and after removing it keep in the desiccator.
- Weigh 5 gram of grounded and dried sample and place it in the thimble.
- Place the thimble in the soxhlet extractor.
- Take a 150ml round bottom flask and clean it and fill the flask with 90 ml petroleum ether.
- Place the whole setting on a heating mantle and allow the petroleum ether to boil.
- Continue the extraction process for several hours, almost 6 hours.
- Remove the condensing unit from extraction unit and allow the sample to cool down. Finally, it removes all the lipid.
- Collect almost all the solvent after distillation.
- Place the sample in the oven and after removing it place in the desiccator.
- Take the weight of the sample.
- As a result, we get a defat sample.

Calculation : Fat per centage = (w2-w1)/p × 100

APPENDIX XI

Estimation of Beta – Carotene

Principle:

The individual Carotenoids are separated on a column of calcium hydroxide or alumina and determined spectrophotometrically. The values for their respective Vitamin A potency are used to arrive at the total Vitamin A value of the foodstuff.

Procedure:

Preparation of the sample: Twenty five g of freshly ground sample is allowed to stand overnight in a mixture of 100 ml of petroleum ether: acetone (1:1). The extract is then filtered and the residue on the filter, washed twice with successive 500 ml portions of the mixture till all the yellow colour is extracted. The pooled filtrate is shaken with 50 ml portions of water and water washings discarded. This is repeated twice. The solvent layer is then dried over anhydrous sodium sulphate and concentrated under reduced pressure (flash evaporation) to a finall volume of 4 ml.

Separation of pigments using calcium hydroxide column: A column of 30 x 1 cm is packed with 6 g of calcium hydroxide under gentle suction. About 1-2 g of anhydrous sodium sulphate is placed on top of the packed column. The column is initially wet by passing petroleum ether.

Two ml of the concentrated extract containing about 40 – 100 µg of the total carotene is loaded on the column. Light suction is employed and a 1 per cent acetone in petroleum ether is used as developing solvent.

The separated bands are individually eluted and their spectra studied in a spectrophotometer to identify the different carotene fractions.

For quantitative estimation of different carotene fractions, standard graphs are obtained with graded concentrations of pure beta carotene dissolved in petroleum ether and this curve is used for determining the concentrations of the solutions of pigments whose main absorption is around 460 nm.

Separation using alumina column: Two ml of the concentrated carotene extract is loaded on to a column of alumina (10 x 1 cm) containing 3 per cent

anhydrous sodium sulphate. The beta carotene is eluted with petroleum ether containing 3 per cent acetone. The volume of the eluate is made up to 5 ml and OD is measured at 450 nm.

Calculation:

1 OD is equivalent to 4 µg / ml of beta carotene when measured in a cell of 1 cm light path.

The relative potencies of different Carotenoids reported in the literature are used to calculate the vitamin A value in the case of each carotenoid fraction. The sum of the values of all the fractions present in the chromatogram of a particular foodstuff gives its true vitamin A value.