



**LUNCH BOX IDEAS TO FIGHT
ANAEMIA AMONG ADOLESCENT
GIRLS**

**Project Submitted To
MAHATMA GANDHI UNIVERSITY**

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**SUBMITTED BY
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PROJECT WORK
IN
LUNCH BOX IDEAS TO FIGHT ANAEMIA
AMONG ADOLESCENT GIRLS
(B.Sc. Final Year: AB20HSC019)

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INDEX

SL. NO	TITLE	PAGE NO.
1	INTRODUCTION	1
2.	REVIEW OF LITERATURE	4
3.	METHODOLOGY	12
4.	RESULTS AND DISCUSSION	14
5.	SUMMARY AND CONCLUSION	28
6.	BIBLIOGRAPHY	30
7.	APPENDIX	

LIST OF FIGURES

SL. NO	PARTICULARS	PAGE NO.
1.	Figure 1: Lunch Box Items	26

LIST OF TABLES

SL. NO.	PARTICULARS	PAGE NO.
1.	Table 1:- List of Raw Food Materials with their Cost and Nutrients present in it.	15-18
2.	Table 2:- Nutritive Value of the Ingredients of Beetroot Paratha with Raitha.	22
3.	Table 3 :- Nutritive Value of the Ingredients of Lemon Rice with Potato Fry	22
4.	Table 4:- Nutritive Value of the Ingredients of Amaranth Dal with Rice	23
5.	Table 5:- Nutritive Value of the Ingredients of Egg Fried Rice with Dates Pickle.	23
6.	Table 6:- Nutritive Value of the Ingredients of Bhindi Fry with Stuffed Chapathi.	23
7.	Table 7:- Nutritive Value of Ingredients of Rice Flour Dosa with Tomato Chutney	24
8.	Table 8:- Consolidated Table of Mean Value of the Sensory Evaluation of the Prepared Lunch Box Recipes for Comparison.	25
9.	Table 9:- Consolidated Table of Mean Value of the Sensory Evaluation of the Prepared Lunch Box Recipes for Comparison.	27

LIST OF APPENDIX

- **Appendix 1**

Table 10:- Sensory Evaluation Table of Beetroot Paratha with Raitha

Table 11:- Sensory Evaluation Table of Lemon Rice with Potato Fry

Table 12:- Sensory Evaluation Table of Amaranth Dal with Rice

Table 13:- Sensory Evaluation Table of Egg Fried Rice with Dates Pickle

Table 14:- Sensory Evaluation Table of Bhindi Fry With Chapathi and Amaranth Dal

Table 15:- Sensory Evaluation Table of Rice Flour Dosa with Tomato Chutney

- **Booklet of the Modified Lunch Box Recipes**

- **Appendix 2**

Table 16;- Nutritive Value of the Ingredients of Beetroot Paratha with Raitha

Table 17:- Nutritive Value of the Ingredients of Lemon Rice with Potato Fry

Table 18:- Nutritive Value of the Ingredients of Amaranth Dal with Rice

Table 19:- Nutritive Value of the Ingredients of Egg Fried Rice with Dates

Pickle

Table 20:- Nutritive Value of the Ingredients of Bhindi Fry with Stuffed Chapathi

Table 21:- Nutritive Value of the Ingredients of Ragi Dosa with Tomato Chutney

- **Appendix 3**

Table 22:- Sensory Evaluation Table of Beetroot Paratha with Raitha

Table 23:- Sensory Evaluation Table of Lemon Rice with Potato Fry

Table 24:- Sensory Evaluation Table of Amaranth Dal with rice

Table 25:- Sensory Evaluation Table of Egg Fried Rice with Dates Pickle

Table 26:- Sensory Evaluation Table of Bhindi Fry with Stuffed Chapathi

Table 27:- Sensory Evaluation Table of Ragi Dosa with Tomato Chutney

CHAPTER 1: INTRODUCTION

Lunch Box menu decision is a challenging task than cooking the menu itself. The lunch hours of the day are when our metabolism is at its peak. Lunch needs to be the ideal balance of protein, fibre, sugar and fat, basically all things good. Roger Troy Wilson, author of the book 'Let's do Lunch' published in May 2009 says, "adding vegetables and fruits in your lunch provides a lot of valuable vitamins and minerals to a person's overall eating plan. This includes Potassium, Folate, Niacin, Vitamin A, Vitamin B6 and B12, Vitamin C, minerals and phytochemicals"(Roger Troy Wilson, 2009).

Every student wants to do well in their academics. And taking a full, nutritious lunch can lead to better cognitive function. It is one of the best ways to boost your memory. It could also improve your ability to conceptualize and solve problems. Taking lunch may lead to better attention spans and higher test scores. To achieve this, you need to take something with the necessary iron levels (Karl Bowman, 2014).

Lunch is an important meal of the day especially for adolescent students. However, often higher secondary and college going students may not have enough time for eating due to the volume of homework (Karl Bowman, 2014). By eating lunch, you will enjoy an improved mood and socialize with your classmates better (Tumer J., 2022).

Eating lunch regularly raises the blood sugar levels giving you instant energy to keep going. You will be able to concentrate and focus throughout the day. Eating at least a small portion of lunch can renew your energy and create a sense of alertness. One will feel refreshed to proceed with learning for the rest of the day. Adolescents should understand that their behaviour could improve by taking lunch, especially by focusing on meals that meet one's nutritional needs. Eating lunch could also lead to fewer disruptions during lessons (Karl Bowman, 2014).

For younger people, lunch is significant because this is the time they get the necessary nutrients. Breakfast will be done in a hurry or skipped and dinners are in general lighter mostly in our culture. So, eating a balanced meal at lunchtime is sure to improve one's physical development and behaviour. This will also help adolescents gain energy to develop physically and mentally. Foods rich in Magnesium and vitamins B and C help to improve your concentration and productivity. Younger students are more prone to viral infections- they pick germs faster. One of the best ways to boost your immune system is by taking lunch. Take foods that boost your immune system. The healthier you are, the lower the chances of skipping classes due to sickness. Healthy options include Omega 3 fatty acids and important vitamins. Instituting practices to improve your immune system reduces your health risk (Karl Bowman, 2014).

Anaemia is a condition in which you lack enough healthy red blood cells to carry adequate oxygen to your body's tissues. Having anaemia, also referred to as low haemoglobin, can make you feel tired and weak. Anaemia happens when you do not have enough red blood

cells. The cells travel with iron and haemoglobin, which is a protein that helps carry oxygen through the bloodstream to your organs all through the body. When someone develops anaemia, they are said to be 'anaemic'. Being anaemia might mean that you feel more tired or cold than you usually do, or if your skin seems too pale. This is due to your organs not receiving the oxygen they need to do their jobs, and you may feel very tired for several days despite getting rest. Most of the time, anaemia is a short-term issue easily treated by changing your diet or taking supplements. Yet untreated, anaemia may cause serious medical issues (Tumer J, 2022).

There are different types of anaemia, but each of them causes the number of red blood cells in circulation to drop. Anaemia affects more than two billion people globally which is more than 30 percent of the total population. It is especially common in countries with few resources, but it also affects many people in the industrialized world (Tumer J, 2022).

Anaemia is widespread in India, that is, 58.6% of children, 53.2% of non-pregnant women and 50.4% of pregnant women were found to be anaemic in 2016, as per the NFHS. India carries the highest burden of the disease despite having an anaemia control programme for 50 years (Govindraj Ethiraj, 2011).

Anaemia is a more sensitive indicator of women's health than any other and according to the data in the National Family Health Survey (NFHS-5, 2019-21), 36% of women in Kerala are anaemic which is a 2% increase from the data of 2015-16 (Manjula V.D., 2014).

Anyone can develop anaemia, although the following groups have a higher risk: Women, infants, children and people over 65. Among all the categories the women of menarche age upwards suffer a lot of blood loss during monthly periods and childbirth which lead to anaemia. This is especially true if you have heavy periods or a condition like fibroids (Tumer J, 2022)

Several signs and symptoms occur in all types of anaemia, such as: Fatigue, Shortness of breath, Feeling cold, Dizziness or weakness, Headache, Sore tongue, Pale skin, dry skin or easily bruised skin, Unintended movement in the lower leg(restless legs syndrome), Fast heartbeat (Tumer J,2022)

The most common cause of anaemia is low levels of iron in the body. This type of anaemia is called Iron-deficiency anaemia. Your body needs a certain amount of iron to make haemoglobin, the substance that moves oxygen throughout your body (Tumer J, 2022).

Statement of the Research Problem

Adolescent years are marked physical activity and rapid growth spurt; therefore, they need additional nutritional supplements and are at utmost risk of developing nutritional anaemia. Anaemia plays a major role in affecting adolescents, especially girls and the situation is grave in our nation including Kerala.

Aim

To develop and introduce some nutritious lunch box ideas to reduce the risk of anaemia among adolescent girls.

Objectives

- To identify nutrients required for fighting anaemia.
- To identify locally available food items appropriate to be included in the meals as anaemia reducing lunch items.
- To identify the RDA(Recommended Daily Allowance) of nutrients required to fight anaemia.
- To develop complete and easy meals for lunch boxes from the identified food items suitable for fighting anaemia.
- To evaluate the prepared lunch box recipes on the nutritional adequacy and conduct a hedonic scale sensory evaluation of the same.

CHAPTER 2: REVIEW OF LITERATURE

A literature review is a comprehensive summary of previous research on a topic. The literature review surveys scholarly articles, books, and other sources relevant to a particular area of research. The review should enumerate, describe, summarize, objectively evaluate and clarify this previous research. It should give a theoretical base for the research and help you (the author) determine the nature of your research. A literature review creates a "landscape" for the reader, giving her or him a full understanding of the developments in the field. This landscape informs the reader that the author has indeed assimilated all (or the vast majority of) previous, significant works in the field into her or his research (Enwonure,1993).The information gathered through literature review prior to the actual conduct of the study is classified under the following headings.

**2.1. Anaemia and Women 2.2. Types and causes of Anaemia 2.3. Treatment of Anaemia
2.4. Role of Lunch in adolescents 2.5. Related studies from the field**

2.1. Anaemia and Women

Anaemia is one of the most critical health conditions affecting people worldwide. The disease is silent, with a slow progression and a few physical symptoms. Anaemia during pregnancy carries the risk of premature birth, low birth weight, and Foetus malformations and can impose additional costs on society and families. In a review study conducted on the prevalence of anaemia in pregnant women worldwide (WHO, 1992).

The Google Scholar, Cochrane, Science Direct, Medline (PubMed), and Web of Science (WoS) databases were searched for articles published between 1991 and 2021. The search keywords were anaemia, pregnancy, prevalence, and meta-analysis. The search resulted in 338 reduplicated studies, of which 52 studies with a total sample size of 1,244,747 people were included in this review. According to the results of the meta-analysis, the overall prevalence of anaemia in pregnant women is 36.8% (95% confidence interval: 31.5–42.4%). The highest prevalence of anaemia is mild at 70.8 (95% CI 58.1–81) and highest in the third trimester of pregnancy with the prevalence of 48.8 (95% CI 38.7–58.9), while the highest prevalence of anaemia in pregnant women was in Africa with the prevalence of 41.7 (95% CI 32.3–49.4). The results of this study show a high prevalence of anaemia among pregnant women worldwide, and the highest of this prevalence is mild anaemia. The prevalence of anaemia in the third trimester was higher than in the first and second trimesters. Anaemia in pregnant women in developing countries is significantly higher than in developed countries due to pregnancy's economic, sociological, and health factors (WHO, 1992).

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than in developed countries due to pregnancy's economic, sociological, and health factors (WHO, 1992).

Women are especially likely to develop anaemia for several reasons. First, women aged 12 to 49 lose blood approximately once a month during their periods. The risk of anaemia is higher among women with periods that are especially long or include very heavy bleeding. Some women also lose iron from uterine fibroids (non-cancerous growths in the womb) that bleed slowly, or from bleeding caused by using certain intrauterine devices (IUDs) for birth control (WHO, 1992).

Second, women need extra iron during pregnancy for the proper development of their babies. In fact, pregnant women need 50 percent more iron than usual (27 mg per day instead of the usual 18 mg per day). Women also lose blood during childbirth (WHO,1992).

Iron deficiency and anaemia are global health problems and major causes of morbidity in women. Current definitions of anaemia in women are historic and have been challenged by recent data from observational studies. Menstrual loss, abnormal uterine bleeding and pregnancy put women at risk of developing iron deficiency which can result in severe fatigue, reduced exercise capacity and poor work performance. Iron deficiency and anaemia during pregnancy are associated with adverse maternal and foetal outcomes, including neurocognitive deficits in children born to iron-deficient mothers. Both iron deficiency and anaemia are common in women undergoing surgery but their association with poor outcomes remains uncertain (WHO,1992).

Anaemia can be due to a condition present at birth (congenital) or to a condition you develop (acquired). Anaemia occurs when your blood doesn't have enough red blood cells.

This can happen if:

- Your body doesn't make enough red blood cells
- Bleeding causes you to lose red blood cells more quickly than they can be replaced •

Your body destroys red blood cells

2.2. Types and Causes of Anaemia

Anaemia is a condition in which you lack enough healthy red blood cells to carry adequate oxygen to your body's tissues. Having anaemia, also referred to as low haemoglobin, can make you feel tired and weak (Tumer J, 2022).

There are many forms of anaemia, each with its own cause. Anaemia can be temporary or long term and can range from mild to severe. In most cases, anaemia has more than one cause. See your doctor if you suspect that you have anaemia. It can be a warning sign of serious illness (Tumer J,2022).

Some types of anaemia that you may have heard of include:

- ☆ Iron-deficiency anaemia
- ☆ Sickle cell anaemia
- ☆ Megaloblastic anaemia
- ☆ Pernicious anaemia

Different types of anaemia have different causes. They include:

- **Iron deficiency anaemia.** This most common type of anaemia is caused by a shortage of iron in your body. Your bone marrow needs iron to make haemoglobin. Without adequate iron, your body can't produce enough haemoglobin for red blood cells.

Without iron supplementation, this type of anaemia occurs in many pregnant women. It's also caused by blood loss, such as from heavy menstrual bleeding; an ulcer in the stomach or small bowel; cancer of the large bowel; and regular use of some pain relievers that are available without a prescription, especially aspirin, which can cause inflammation of the stomach lining resulting in blood loss. It's important to determine the source of iron deficiency to prevent recurrence of the anaemia.

- **Vitamin deficiency anaemia.** Besides iron, your body needs folate and vitamin B-12 to produce enough healthy red blood cells. A diet lacking in these and other key nutrients can cause decreased red blood cell production. Some people who consume enough B-12 aren't able to absorb the vitamin. This can lead to vitamin deficiency anaemia, also known as pernicious anaemia.
- **Anaemia of inflammation.** Certain diseases — such as cancer, HIV/AIDS, rheumatoid arthritis, kidney disease, Crohn's disease and other acute or chronic inflammatory diseases — can interfere with the production of red blood cells.
- **Aplastic anaemia.** This rare, life-threatening anaemia occurs when your body doesn't produce enough red blood cells. Causes of aplastic anaemia include infections, certain medicines, autoimmune diseases and exposure to toxic chemicals.
- **Anaemias are associated with bone marrow disease.** A variety of diseases, such as leukaemia and myelofibrosis, can cause anaemia by affecting blood production in your bone marrow. The effects of these types of cancer and cancer-like disorders vary from mild to life-threatening.
- **Hemolytic anaemia.** This group of anaemias develops when red blood cells are destroyed faster than bone marrow can replace them. Certain blood diseases increase red blood cell destruction. You can inherit a hemolytic anaemia, or you can develop it later in life.
- **Sickle cell anaemia.** This inherited and sometimes serious condition is hemolytic anaemia. It's caused by a defective form of haemoglobin that forces red blood cells to assume an abnormal crescent (sickle) shape. These irregular blood cells die prematurely, resulting in a chronic shortage of red blood cells (John Schieszer, 2018).

All different types of anaemia cause the number of red blood cells in circulation to drop. Red blood cells are low due to one of the following reasons:

- Your body cannot make enough haemoglobin(low haemoglobin).
- Your body makes haemoglobin, but the haemoglobin doesn't work correctly.
- Your body does not make enough red blood cells.
- Your body breaks down red blood cells too quickly.

Anaemia caused by Iron deficiency is one of most wide-spread diseases in the world. Children in school and especially in the age of adolescence will come to experience the danger of anaemia based on iron deficiency. In this age anaemia will have a fast growth (Enwonure,1993).

2.2.1. Risk causing factors

These factors place you at increased risk of anaemia:

- A diet lacking in certain vitamins and minerals. A diet consistently low in iron, vitamin B12, folate and copper increases your risk of anaemia.
- Intestinal disorders: Having an intestinal disorder that affects the absorption of nutrients in your small intestine — such as Crohn's disease and celiac disease — puts you at risk of anaemia.
- Menstruation: In general, women who haven't had menopause have a greater risk of iron deficiency anaemia than do men and postmenopausal women. Menstruation causes the loss of red blood cells.
- Pregnancy: Being pregnant and not taking a multivitamin with folic acid and iron, increases your risk of anaemia.
- Chronic conditions: If you have cancer, kidney failure or another chronic condition, you could be at risk of anaemia or chronic disease. These conditions can lead to a shortage of red blood cells. Slow, chronic blood loss from an ulcer or other source within your body can deplete your body's store of iron, leading to iron deficiency anaemia.
- Family history: If your family has a history of an inherited anaemia, such as sickle cell anaemia, you also might be at increased risk of the condition.
- Other factors: A history of certain infections, blood diseases and autoimmune disorders increases your risk of anaemia. Alcoholism, exposure to toxic chemicals and the use of some medications can affect red blood cell production and lead to anaemia.
- Age: People over age 65 are at increased risk of anaemia (Enwonure,1993).

2.2.2 Complications: Left untreated, anaemia can cause many health problems, such as:

- Extreme fatigue: Severe anaemia can make you so tired that you can't complete everyday tasks.

- Pregnancy complications: Pregnant women with folate deficiency anaemia can be more likely to have complications, such as premature birth.
- Heart problems: Anaemia can lead to a rapid or irregular heartbeat (arrhythmia). When you're anaemic your heart pumps more blood to make up for the lack of oxygen in the blood. This can lead to an enlarged heart or heart failure.
- Death: Some inherited anaemias, such as sickle cell anaemia, can lead to life-threatening complications. Losing a lot of blood quickly results in acute, severe anaemia and can be fatal. Among older people, anaemia is associated with an increased risk of death (Enwonure,1993).

2.3. Treatment of Anaemia

2.3.1 Major nutrients required to fight Anaemia

Nutritional anaemia is the most common type of anaemia worldwide and mainly includes iron, folic acid, Vitamin B₁₂ and Vitamin C deficiencies.

Anaemia happens when your body doesn't have enough healthy red blood cells. The condition is mainly caused by blood loss, the destruction of red blood cells, or your body's inability to create enough red blood cells. There are many types of anaemia. The most common type is iron deficiency anaemia. Red blood cells contain a protein called haemoglobin. Haemoglobin is full of iron. Without sufficient iron, your body can't make the haemoglobin it needs to create enough red blood cells to deliver oxygen-rich blood throughout your body (Major Issues for Nutrition Strategies,1992).

A lack of folate and vitamin B-12 may also impact your body's ability to make red blood cells. If your body can't process B-12 properly, you may develop pernicious anaemia. A diet rich in iron, B vitamins, and vitamin C like the plan below is important if you have anaemia. Be sure to talk to your healthcare provider about supplements as well (Major Issues for Nutrition Strategies,1992).

Anaemia treatment plans often include dietary changes. The best diet plan for anaemia includes foods rich in iron and other vitamins essential to haemoglobin and red blood cell production. It should also include foods that help your body absorb iron better. There are two types of iron in foods: heme iron and nonheme iron. Heme iron is found in meat, poultry, and seafood. Non Heme iron is found in plant foods and foods fortified with iron. Your body can absorb both types, but it absorbs heme iron more easily (Major Issues for Nutrition Strategies,1992).

Many types of anaemia can't be prevented. But you can avoid iron deficiency anaemia and vitamin deficiency anaemias by eating a diet that includes a variety of vitamins and minerals, including:

- Iron: Iron-rich foods include beef and other meats, beans, lentils, iron-fortified cereals, dark green leafy vegetables and dried fruit.

- Folate: This nutrient, and its synthetic form folic acid, can be found in fruits and fruit juices, dark green leafy vegetables, green peas, kidney beans, peanuts, and enriched grain products, such as bread, cereal, pasta and rice.
- Vitamin B-12: Foods rich in vitamin B-12 include meat, dairy products, and fortified cereal and soy products.
- Vitamin C: Foods rich in vitamin C include citrus fruits and juices, peppers, broccoli, tomatoes, melons and strawberries. These also help increase iron absorption (Major Issues for Nutrition Strategies,1992).

2.4 Role of Lunch in Adolescents

Diet quality of children consuming school meals tends to be better than that of children consuming packed lunches (from home) or food bought outside school (ESN- Nutrition Country Profile,1991).

Eating healthy is an important part of a healthy lifestyle and is something that should be taught at a young age. The following are some general guidelines for helping your adolescent eat healthy. It is important to discuss your adolescent's diet with his or her health care provider before making any dietary changes or placing your adolescent on a diet. Discuss the following healthy eating recommendations with your adolescent to ensure he or she is following a healthy eating plan:

- Eat 3 meals a day, with healthy snacks.
- Increase fiber in the diet and decrease the use of salt.
- Drink water. Try to avoid drinks that are high in sugar. Fruit juice can have a lot of calories, so limit your adolescent's intake. Whole fruit is always a better choice.
- Eat balanced meals.
- When cooking for your adolescent, try to bake or broil instead of fry.
- Make sure your adolescent watches (and decreases, if necessary) his or her sugar intake.
- Eat fruit or vegetables for a snack.
- Decrease the use of butter and heavy gravies.
- Eat more chicken and fish. Limit red meat intake, and choose lean cuts when possible (ESN- Nutrition Country Profile,1991).

2.4.1 Healthy eating during adolescence

Healthy eating during adolescence is important as body changes during this time affect an individual's nutritional and dietary needs. Adolescents are becoming more independent and making many food decisions on their own. Many adolescents experience a growth spurt and an increase in appetite and need healthy foods to meet their growth needs. Adolescents tend to eat more meals away from home than younger children. They are also heavily influenced by their peers. Meal convenience is important to many adolescents and they may be eating too much of

the wrong types of food, like soft drinks, fast-food, or processed foods (ESN- Nutrition Country Profile,1991).

Also, a common concern of many adolescents is dieting. Girls may feel pressure from peers to be thin and to limit what they eat. Both boys and girls may diet to "make weight" for a particular sporting or social event (ESN- Nutrition Country Profile, 1991).

The following are some helpful considerations as you prepare meals for your adolescent:

- Arrange for teens to find out about nutrition for themselves by providing teen-oriented magazines or books with food articles and by encouraging them and supporting their interest in health, cooking, or nutrition.
- Take their suggestions, when possible, regarding foods to prepare at home.
- Experiment with foods outside your own culture.
- Have several nutritious snack foods readily available. Often, teenagers will eat whatever is convenient.
- If there are foods that you do not want your teens to eat, avoid bringing them into the home (ESN- Nutrition Country Profile,1991).

2.5 Related studies from the field

Anaemia is defined as a reduction in the haemoglobin concentration of blood, which consequently reduces the oxygen-carrying capacity of red blood cells such that they are unable to meet the body's physiological needs.

A study investigating the association between different types of lunch consumed in a school day and diet quality of UK adolescents among a total of 2118 British adolescents were included from the National Diet and Nutrition Survey (Years 1–8; between 2008 and 2016). All participants attended school and were aged 11–18 years with valid 3 or 4-day diary records and the analyses were stratified by age group (11–14 and 15–18 years). The **Diet Quality Index for Adolescents (DQI-A)** tool consisting of three components; Diet quality, Diversity and equilibrium, was used to assess adherence to dietary recommendations. Overall DQI-A scores range from –33 to 100%. Overall mean DQI-A score for all adolescents was low at 21.1%. Fewer (17.4%) adolescents reported buying lunches from cafés and shops, compared to adolescents consuming cooked school meals and packed lunches (28.3% and 36.6%, respectively), and they had the lowest DQI-A% score of 14.8%. Adolescents having cooked school meals (reference group) had a higher overall DQI-A% of 21.8%. Diet quality scores of older adolescents having packed lunches and shop/café-bought lunches were 5.5% higher (CI 2.7 to 8.4%; $p < 0.01$) and 5.0% lower (CI 8.1 to 2.0%; $p < 0.01$) than cooked school meals respectively, after adjusting for gender, region, energy under-reporting and equalized household income. For younger adolescents the results were attenuated particularly among packed lunch consumers. UK adolescents generally consume a poor quality diet and adolescents purchasing lunches from outside the school gates have the lowest quality diets (ESN- Nutrition Country Profile,1991).

CHAPTER 3: METHODOLOGY

Research Methodology simply refers to the practical “how” of any given piece of research. More specially, it about how a researcher systematically design a study to ensure valid and reliable results that addresses the experimental study.

The methodology adopted for the study, comprises the various steps to lunch box recipes for adolescent girls to fight against anaemia from locally available food items.

3.1 Identification of Nutrients that are required to fight Anaemia 3.2 Identification and Listing of Raw Food Materials to fight Anaemia (locally available) 3.3 Designing suitable Lunch Box Recipes for Adolescent Girls to fight Anaemia 3.4 Listing out Ingredients and Nutritive Value Calculation 3.5 Checking Nutritional Adequacy 3.6 Organoleptic Evaluation 3.7 Consolidation and Discussion

3.1 Identification of Nutrients: - Nutrients that are required to fight Anaemia and to prevent Anaemia.

3.2 Identification and Listing of Raw Food Materials:- Food items that are rich in nutrients required to fight anaemia and also locally available and affordable.

3.3 Designing suitable Lunch Box Recipes:- According to the identified food items, six lunch box recipes to fight against anaemia are designed for adolescent girls which are simple and easy to make. The cost and preparation time was also calculated.

3.4 Listing out Ingredients and Nutritive Value Calculation:- The ingredients of each recipe are listed out, and then their nutritive value is calculated using “Ntutive App”. Ntutive is all in one nutrition software tool for dietitians and nutritionists, it helps not only to keep a record of their patients or clients, create diet plans, meal plan, manage appointments, in calculating nutritional values of recipes but also is quick and user-friendly (Ntutive App,1991).

3.5 Checking Nutritional Adequacy:- The nutritive value of the prepared recipes are compared based on the Recommended Daily Allowance (RDA) for adolescent girls.

3.6 Organoleptic Evaluation / Hedonic scale sensory evaluation: - The evaluation is done by a panel of purposefully selected adolescent girls (Age limit : 13 to 19) nearby locality. The main particulars collected during the hedonic scale sensory evaluation is given below:- Taste, Appearance, Aroma and Texture of the prepared food.

The grading is from 5 point scale. After the data collection, the average score was calculated. The Grading was divided as given below.

- 4-5.0 – A – Very Good
- 3-3.9 – B – Good
- 2-2.9 – C – Satisfactory
- 1-1.9 – D – Below Average
- 0-0.9 – E – Poor

3.6.1. Expert Evaluation: First the evaluation of the planned menu was done by experts from the department of Home Science. The suggestions from the sensory and nutritive evaluation are incorporated and modifications are made in the recipes.

3.6. 2. Adolescent Evaluation: The final food items are evaluated by setting up a panel consisting of adolescent girls (Age range from 13 to 19). Five students were selected for evaluation ranging in the age group mentioned above.

3.7. Consolidation and Discussion: Consolidated and Discussion of results of the final menus.

CHAPTER 4: RESULTS AND DISCUSSION

Based on the method planned the study is carried out. The data is consolidated and presented in their section,.

4.1 Identification of Nutrients: - Nutrients that are required to fight against anaemia and to prevent from anaemia.

4.1.1 Iron Supplements is used widely, either to to prevent iron deficiency and anaemia in population at risk (eg:- pregnant women and young children), or to improve the haemoglobin status of people with existing anaemia. Iron is an essential element for almost all living organisms as it participates in a wide range of metabolic process, including in a wide range of metabolic process, including oxygen transport, DNA (Deoxyribo Nucleic Acid) synthesis, and electron transport. It also reduces tiredness and fatigue, supports good energy levels and contributes to the normal formation of red blood cells and haemoglobin function, which carries oxygen around the body. In addition to iron, various other micronutrients are important for proper function of hematopoiesis, and deficiencies may contribute to the development of anaemia. They are : -

4.1.2 Folic acid plays a central role in erythropoiesis and pregnant women especially are at high risk of folic acid deficiencies. Folic acid helps your body produce and maintain new cells, and also helps prevent changes to DNA that may lead to cancer.

4.1.3 Vitamin A acts on several stages of iron metabolism; it increase iron uptake, iron mobilization and erythropoiesis. Supplementation during pregnancy is associated with reduced maternal anaemia for women living in areas with a vitamin A deficiency. Vitamin A is needed for eye health vision, immune function, cell growth, reproduction and fetal development.

4.1.4 Vitamin B12 plays a crucial role in erythropoiesis and several vitamin B12 deficiency can lead to the development of megaloblastic anaemia. Vitamin B12 is an essential nutrient that helps the body create DNA, nourishes the brain and nervous system and assists with the formation of healthy red blood cells, support bone health and mood.

4.1.5 Vitamin C helps make red blood cells and maintain healthy red blood cells. It may also prevent blood clots and reduce bruising. It can increase your blood antioxidant levels by up to 30%. It is a nutrient your body needs to form blood vessels, cartilage, muscle and collagen in bones. Vitamin C is also vital to your body's healing process.

4.2 Identification of Raw Food Materials:- Food items that are rich in energy, protein, Iron, folic acid, Vitamin A, Vitamin B12, Vitamin C and also not expensive and affordable to all categories of people are identified.

4.2.1 List of Raw Food Materials with Low Cost and Nutrients Present in it.

Table 1:- List of Food Materials with their Cost and Nutrients Present in it.

The order of foods groups is Cereals and Pulses, Fruits and Vegetables, Green Leafy Vegetables, Other Fruits and Vegetables, Roots and Tubers and Meat and Egg (TNAU Agritech Portal, 2015).

Food Group	Food Items	Veg	Non-Veg	Nutrients present	Cost (In Rs.)
Cereals and Pulses	Moong dal	✓		Folic acid, Vitamin C, Vitamin A	72 (for 1 kg)
	Whole wheat flour	✓		Vitamin A, Vitamin C, Iron	50 (for 1 kg)
	Rice flour	✓		Vitamin C, Iron, Vitamin A	60 (for 1 kg)

	Avil or Rice Flakes)	✓		Iron, Vitamin C	78 (for 1 kg)
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	Ragi	✓		Iron, Vitamin C	298 (for 1 kg)
Fruits and Vegetables	Lotus stem	✓		Iron, Vitamin C	134 (for 1 kg)
	Apple	✓		Vitamin A, Vitamin C, Iron	119 (for 1 kg)
	Papaya	✓		Vitamin C, Vitamin A, Folic acid	40 (for 1 kg)
	Pomegranate	✓		Iron, Vitamin C, Vitamin A	176 (for 1 kg)
Green Leafy Vegetables	Drumstick	✓		Iron, Vitamin A, Vitamin C, Folic acid	24 (for 100 gms)

	Amaranth leaves	✓		Iron, Vitamin A, Vitamin C, Folic acid	127 (for 1 kg)
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Other Fruits and Vegetables	Jackfruit seeds	✓		Iron, Vitamin B12	56 (for 1 kg)
	Bitter gourd	✓		Iron,	66 (for 1 kg)
				Vitamin A, Vitamin C	
	Dates	✓		Iron, Vitamin C, Vitamin A, Vitamin B12	400 (for 1kg)
	Lemon	✓		Vitamin C, Folic acid	89 (for 1 kg)
	Beetroot	✓		Iron, Vitamin C, Folic acid	58 (for 1 kg)
	Tomatoes	✓		Folic acid, Vitamin C, Vitamin A, Iron	15 (for 1 kg)

	Mushroom	✓		Iron, Vitamin C, Folic acid, Vitamin B12	150 (for 1 kg)
Roots and Tubers	Potatoes	✓		Folic acid, Iron, Vitamin C	60 (for 1 kg)

Meat and Egg	Chicken Breast	✓		Iron, Vitamin B12	250 (for 1 kg)
	Beef	✓		Iron,	160 (for 1 kg)
				Vitamin B12, Vitamin A	
	Red Meat	✓		Iron, Vitamin B12	320 (for 1 kg)
	Tuna fish	✓		Iron, Vitamin B12, Vitamin A	320 (for 1 kg)
	Eggs	✓		Iron, Vitamin A, Vitamin B12, Folic acid	60 (for 1 dozen)

	Liver	✓		Iron, Folic acid, Vitamin A, Vitamin B12	60 (for 1 kg)
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Those food items which are less expensive widely popular and readily available was pinpointed and out of the collection 10 food items were finalized. The food items were identified were given below:-

4.2.2 Details of selected food items.

4.2.2.1. Beetroot (Beta vulgaris)

It is a root vegetable also known red beet, table beet, garden beet or just beet packed with essential nutrients. Beetroots are a great source of fiber, folate Gutamin(B9), Manganese, Potassium, Iron and Vitamin C. Beetroots and beet root juice have been associated with numerous health benefits, including improved blood flow, lower blood pressure and increased exercise performance. Many of these benefits are due to their content of inorganic nitrates.

4.2.2.2 Lemon (Citrus Lemon)

Lemon are among the world's most popular citrus fruits. They grows on lemon trees and are a hybrid of the original cotton and lime. There are many ways to enjoy lemons, but they taste very sour and are usually not eaten alone or as a whole fruit. Instead, they are often a garnish with meals and their juice is often used to provide a sour flavor. there are a key ingredients in lemonade. A great source of Vitamin C and fiber, lemons contain many plant compounds, minerals and essential oils. These yellow fruits also have many potential health benefits. Eat lemons may lower your risk of heart disease, caner and kidney stones. Lemons contains small amount of Iron, but they are a great source of Vitamin C and Citric acid, which can increase the absorption of Iron from other foods.

4.2.2.3Potato

Potato are underground tubers that grow on the roots of the potato plants, Solanum tuberosum. Cooked potatoes with the skin are a good source of many Vitamins and Minerals, such as Potassium, Vitamin C, Folate, Vitamin B6. Potatoes contain a number of minerals and plant compounds that may help lower blood pressure. Potatoes may aid weight management by helping you to reduce overall intake.

4.2.2.4 Amaranth Leaves

Green Amaranth (*Amaranthus viridis*) also known as slender amaranth; Amaranth leaves contain Vitamin A, Vitamin C, Vitamin B6, Vitamin B9, Riboflavin, Niacin, Calcium, Omega-3 fatty acids, Iron, Phosphorus and many essential minerals and nutrients. Regular consumption of these leaves bring various health benefits. Amaranth leaves are a storehouse of essential phytonutrients and antioxidants which help to reduce inflammation in the body and provide an extra boost of nutrition to one's health. Traces of fat and absolutely no cholesterol make them a healthy go-to food option, especially those who are watching their weight or who want to reduce it. They are rich in soluble and insoluble fibre which reduces our weight and wards off heart disease as it lowers the cholesterol in the blood. It facilitates maximum absorption of Iron in the blood and boosts immunity.

4.2.2.5 Eggs

Eggs are protein and nutrient powerhouse. Hard-boiled eggs offer various important nutrients, including Vitamin D, Zinc, Calcium and all of the B Vitamins. They are a particularly good source of riboflavin (Vitamin B2) and Vitamin B12. Eggs are one of the best source of protein you can eat. They are high in cholesterol but don't increase heart disease risk. Eggs provide important essential nutrients and antioxidants that support brain and eye health.

4.2.2.6 Bhindi (Ladies finger)

One of the peculiar signs of this vegetable is the internal stickiness. It consists of good amount of carotenoids that maintain vision. The Vitamin Folate (B9) present in Bhindi is required for blood RBC production. There are also fair amounts of Vitamin C, which boosts immunity. There are good amounts of dietary fiber present, hence it is low in calories and considered good for people on weight loss diet. The soluble fibre in Bhindi can help in relieving constipation by adding bulk to the diet and helps to lower serum cholesterol reducing the risk of heart disease.

4.2.2.7 Dates

There lies no doubt in the richness of Vitamins and Minerals present in dates. They are highly rich in Pyridoxine (Vitamin B6), Iron, Vitamin A and K. They are deeply beneficial for the body as they contain rich nutrients and carry a lot of importance in regulating cholesterol levels, bone health and boost cognitive importance. Dates are naturally sweet and provide no added sugar and supports digestive health. They also protect heart and health and blood sugar regulation and offer brain protection.

4.2.2.8 Drumstick Leaves/ Moringa Leaves

Drum stick or Moringa oleifera is a drought resistance tree native to tropical areas. Every part of the tree is valuable, including flowers, pods and leaves. Drumsticks are a crucial ingredient in traditional medicines, as both the pods and leaves are beneficial in various ailments' treatment. Moringa leaves are rich in Vitamins, Antioxidants and Minerals. Moringa leaves are a rich source of Vitamin A, B1, B2, B6, C and folate. They also contain Magnesium, Calcium, Zinc, Iron and Phosphorous.

Moringa leaves contain isothiocyanates which have anti-inflammatory actions. As we already know, inflammation is the root cause of various diseases such as osteoarthritis, cancer, rheumatoid arthritis, traumatic injury and many autoimmune illness. Drumstick leaves are rich in antioxidants, such as Vitamin C and beta-carotene, which protect us from many chronic oxidative diseases including heart diseases, diabetic, cancer and Alzheimer's disease. These leaves also contain Quercetin (an antioxidants) that helps lower blood pressure. Daily consumption of moringa leaves significantly decreases blood cholesterol levels and improves our heart health. Moringa leaves and pods are effective against arsenic toxicity. Long-term arsenic exposure can cause serious health issues such as cancer and heart diseases. Consuming drumstick leaves are beneficial for various digestive issues, such as bloating, constipation, gastritis, and ulcerative colitis. Drum stick leaves are rich in calcium and phosphorous, which are crucial for bone health.

4.2.2.9 Liver

Liver is a rich source of Vitamins and Minerals. However, the same thing that makes liver so potent can also create complications for people with certain medical conditions. Liver is one of the most nutritionally dense foods on the planet. It contains significant amounts of Folate, Iron, Vitamin B, Vitamin A and Copper. Eating a single serving of liver can help you meet your daily recommended amount of all of these Vitamins and Minerals, reducing your risk of nutrient deficiency. Liver is an excellent source of both Iron and Vitamin B12, which work in combination to keep your blood cells in good working condition. In fact, one of the earliest treatments for pernicious anaemia was regularly eating beef liver. Today, adding a few servings of Iron to your weekly diet can help alleviate or prevent anaemia. Liver is full of Vitamin K, which is critical to the health of your bones. Vitamin K helps your body process calcium and add it to your bones. As a result, it helps you maintain the strength of your skeletal system. Getting enough Vitamin K in your diet has been linked to a reduced risk of chronic conditions such as osteoporosis.

4.2.2.10 Tomatoes

Tomatoes are low in calories and provide important nutrients like Vitamin C and Potassium. They're also rich in antioxidants- one called lycopene, responsible for tomatoes' characteristic color, which is linked to several benefits, such as a reduced risk of heart disease and certain cancer.

The Vitamin C in tomatoes acts as an antioxidants and is important for skin, bones and connective tissues. It also promotes healing and helps the body absorb Iron, Potassium, a

mineral needed to build proteins in the body, including muscle; breakdown and use carbohydrates; and regulate heart rhythm and pH balance. Vitamin K is required for blood to clot and also helps maintain strong bones in older adults. Folate helps produce DNA, the building of the human body. It also helps to form red blood cells to prevent anaemia and works with Vitamins B12 and C to help the body breakdown, use, create new proteins and tissues.

4.3 Designing Lunch Box Recipes:- According to the identified food items, six lunch box recipes are designed for adolescent girls. The student has developed 6 recipes using nutrient rich food ingredients.

1. Beetroot paratha with Raitha
2. Lemon rice with potato fry
3. Amaranth Dal with Rice
4. Egg fried rice with Dates pickle.
5. Bhindi fry with chapathi and amaranth dal
6. Rice four dosa with tomato chutney.

4.4 Listing out Ingredients and Nutrients Value Calculations: The ingredients of each original recipe are listed out, and then nutritive value is calculated

4.4.1 Nutritive value of Beetroot Paratha with Raitha

Table 2:- Nutritive value of Beetroot Paratha with Raitha

Ingredients	Energy (k cal)	Protein (g)	Iron (mg)	Folic acid (mg)	VitA (mg)	Vit B12 (mg)	Vit C (mg)
Total	205.13	7.7	2.72	54.76	147.37	0.04	9.43

- It has good energy, moderate protein and Iron content.

4.4.2 Nutritive value of Lemon Rice with Potato Fry

Table 3:- Nutritive value of Lemon Rice with Potato Fry

Ingredients	Energy (k cal)	Protein (g)	Iron (mg)	Folic acid (mg)	VitA (mg)	Vit B12 (mg)	Vit C (mg)
Total	323.94	13.33	3.39	47.28	162.17		58.3

- It has good energy, protein and Iron content.

4.4.3 Nutritive value of Amaranth Dal with Rice

Table 4:- Nutritive value of Amaranth Dal with Rice

Ingredients	Energy (k cal)	Protein (g)	Iron (mg)	Folic acid (mg)	Vit A (mg)	Vit B12 (mg)	Vit C (mg)
Total	321.74	17.74	7.28	95.31			57.29

- It has good energy, moderate protein and good Iron content.

4.4.4 Nutritive value of Egg fried Rice with Dates Pickle.

Table 5:- Nutritive value of Egg fried Rice with Dates Pickle.

Ingredients	Energy (k cal)	Protein (g)	Iron (mg)	Folic acid (mg)	Vit A (mg)	Vit B12 (mg)	Vit C (mg)
Total	356.64	17.64	4.93	17.4	209.72	0.9	8.35

- It has good energy moderate Protein and Iron content.

4.4.5 Nutritive value of Bhindi Fry with Chapathi and Amaranth Dal

Table 6:- Nutritive value of Bhindi Fry with Chapathi and Amaranth Dal

Ingredients	Energy (kcal)	Protein (g)	Iron (mg)	Folic acid (mg)	Vit A (mg)	Vit B12 (mg)	Vit C (mg)
Total	400.71	17.11	8.63	164.67	882.41		94.52

- It has high energy, good Protein and Iron content.

4.4.6 Nutritive value of Rice Flour Dosa with Tomato Chutney.

Table 7:- Nutritive value of Rice Flour Dosa with Tomato Chutney

Ingredients	Energy (k cal)	Protein (g)	Iron (mg)	Folic acid (mg)	VitA (mg)	Vit B12 (mg)	Vit C (mg)
Total	555.44	13.09	3.57	19.92	0.22		6.84

- It has good energy, Protein and Iron content

4.5 Checking Nutritional Adequacy:- The nutritive value of the prepared recipes are compared with Recommended Daily Allowance (RDA) for adolescent girls. It was evident that each of these items are part of the menu for a day and it need out fulfill the RDA of one whole day. The developed recipes provide good supply of iron, found to be easy and simple.

From the RDA for adolescent girls, the following data was selected regarding the major nutrients in anaemia.

- Energy (K cal) = 2200
- Protein (g) = 44-46
- Iron (mg) = 15
- Folic acid (mg) = 150 – 180
- Vitamin A (mg) = 800
- Vitamin B12 (mg) = 2.0
- Vitamin C (mg) = 50-60 (Mathew Bruce,2003).

The Energy, Protein, Iron, Folic acid, Vitamin A, Vitamin B12 and Vitamin C of the above Recipes have 1/3 rd of the RDA for One Day.

4.6 Organoleptic Evaluation / Hedonic Scale sensory evaluation:- Done by two panels. One by Teachers of Home Science department and another by adolescent girls nearby locality. Five teachers are selected for Evaluation.

4.6.1. Expert Evaluation

Consolidated table is given below and the detailed evaluation is given in the **Appendix 1 Table 8:-** Consolidated Table of Mean Value of the Sensory Evaluation of the Prepared Lunch box recipes for comparison.

Sl No.	Items prepared	Sensory evaluation particulars					Average score
		Taste	Appearance	Aroma	Texture	Overall rating	
1.	Beetroot Paratha with Raitha	5	5	4.8	4.9	4.9	4.9
2.	Lemon Rice with Potato Fry	4.3	4.3	4.2	4.6	4.3	4.3
3.	Amaranth Dal with Rice	4	3.9	3.8	4	4.1	3.9
4.	Egg Fried Rice with Dates pickle	4.1	3.7	3.7	4.1	4	3.9
5.	Bhindi fry with Chapathi and Amaranth Dal	3.7	3.6	4	4.1	4.3	3.9
6.	Rice Flour Dosa with Tomato Chutney	3.8	3.7	3.6	4.2	3.9	3.8

- The mean scores showed that the highest rated product was Beetroot paratha followed by Lemon rice, Bhindi fry, Amaranth dal, Egg fried rice and Rice flour dosa. But all these products had good mean scores.

Some suggestions were given by the teachers to add some ingredients and some change in the recipes. In Beetroot Paratha with Raitha the suggestion was to add some lotus stem in the Raitha to increase iron level. In Lemon Rice with Potato Fry the suggestion was to add some drumstick leaves in Potato Fry. In Amaranth Dal with

Rice there was no suggestion. In Egg Fried Rice with Dates Pickle there was no suggestion. In Bhindi Fry With Chapathi and Amaranth Dal the suggestion was to change the Amaranth Dal and make it Stuffed Chapathi. In Rice Flour Dosa with Tomato Chutney the suggestion was to change Rice Flour Dosa to Ragi Dosa.

4.6.2 **Modified Lunch Box Items.**

According to the Suggestions and Evaluation of Teacher's panel some changes and modifications are made in the recipes of the lunch box items.

1. Beetroot Paratha with Raitha
2. Lemon Rice with Potato Fry
3. Amaranth Dal with Rice
4. Egg Fried Rice with Dates Pickle
5. Bhindi Fry with Stuffed Chapathi
6. Ragi Dosa with Tomato Chutney

Figure 1: Lunch box Items



The detailed recipes, step by step procedure is given as a Booklet and its nutritive value and comparison of it with the Original Food Recipes is given in the **Appendix 2.**

4.6.3. Adolescent Evaluation

A Sensory Evaluation was done by a panel available from nearby locality consisting of Adolescent Girls. Five members belonged to adolescent category that is from 13-19 years and their evaluation is considered quite valuable and relevant.

Consolidated table is given below and the detailed evaluation is given in the **Appendix 3**
Table 9:- Consolidated Table of Mean value of the Sensory Evaluation of the Prepared Lunch Box Recipes for Comparison.

Sl No.	Items prepared	Sensory evaluation particulars				Average score
		Taste	Appearance	Aroma	Textures	
1.	Beetroot Paratha with Raitha	3.1	4.1	3.6	3.2	3.5
2.	Lemon Rice with Potato Fry	3.8	3.7	3.9	3.2	3.6
3.	Amaranth Dal with Rice	3.5	4	4	3.7	3.8
4.	Egg Fried Rice with Dates pickle	3.6	3.7	3.8	3.9	3.7
5.	Bhindi Fry with Stuffed Chapathi	4.2	4	4.2	3.8	4
6.	Ragi Dosa with Tomato Chutney	4.1	4	3.6	3.6	3.8

- The mean scores showed that the highest rated product was Bhindi fry followed by Amaranth dal, Rice flour dosa, Egg fried rice, Lemon rice and Beetroot paratha. But all these products had good mean scores. Hence it was concluded that these food items are acceptable and can be given as lunch box recipes to adolescent girls.

CHAPTER 5: SUMMARY AND CONCLUSION

The study entitled “Lunch Box Ideas to Fight Anaemia among Adolescents Girls” was aimed to help adolescent girls to fight against anaemia by introducing some lunch box recipe foods.

The methods used for the study was recipe making by identifying suitable food items for lunch box to fight against anaemia. There are six different types of energy booster food recipes from the identified food items. The results that emerged from the study is summarized as below.

- The food items that are identified as Iron energy, protein and other vitamin rich foods for adolescent girls diets and for recipe preparation are beetroot, lemon, potato, amaranth leaves, eggs, bhindi, rice flour and drumstick leaves.
- The food items beetroot and drum stick leaves are combined together in the recipe called beetroot paratha.
- The recipe called rice flour dosa with tomato chutney gives the highest amount of Iron as 9.66 mg followed by Bhindi fry with stuffed chapathi which gives is 8.63 mg.
- Amaranth dal with rice gives 7.28 mg of Iron for a meal and Egg fried rice with Dates pickle gives 4.93 mg Iron for a meal.

- Among the six recipes, Beetroot paratha with Raitha and Lemon rice with Potato fry gives the lowest amount of Iron as 3.05 and 3.62 for a meal.
- Beetroot paratha with Raitha is a good option for lunch box as it is easily consumable and simple to make.
- Amaranth dal with rice and Egg fried rice with Dates pickle are the next good option for lunch box after Beetroot paratha.
- Amaranth dal and Egg fried rice take the lowest preparation time as 20 minutes. It will be easier and quick to prepare as lunch box recipe in the morning.
- The mean scores showed that the highest rated product in expert evaluation was beetroot paratha and in adolescent girls was Bhindi fry. But all these products had good mean scores. Hence it was concluded that these food items are acceptable and can be incorporated into adolescent girls diets to serve as lunch box recipes.

Conclusion

Adolescence, as a period of growth and development, is considered the best time to intervene, to assist in physical and mental development, to prevent later maternal anaemia. It is known that the adolescent girls are prone for anaemia. Lets join together to help them in eliminating it. The cost of items are not calculated and found to be affordable for all income categories. Hence the recipes if included in the adolescent girls diet can increase the Iron value.

BIBLIOGRAPHY

1. Roger Troy Wilson, 2009, <https://food.ndtv.com/food-drinks/significance-of-morningbreakfast-for-children>.
2. Karl Bowman, 2014, <https://ohmydish.com/blog/the-significance-of-eating-lunch-to-a-student>.
3. Tumer J, Parsi M, Badireddy M, 2022, <https://my.cleveland.clinic.org/health/disease/3929-anaemia>.
4. Govindaraj Ethiraj, 2011, <https://www.google.com/amp/www.indiaspend.com/amp/improve-womenseducationhealth-services-to-reduce-indias-anaemia-burden-worlds-highest/>
5. Manjula VD, Parameshwari P, Pothen L, Sobha A, 2014, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5483718>
6. WHO (1992): Women's health. A Cross Age and Frontier WHO, Geneva, PP: 1-6
7. Enwonure G (1993): Functional Significance of Iron deficiency, annual Nutrition Workshop series, Volume 2, Center for Nutrition Meharry Medical College
8. Major Issues for Nutrition Strategies (1992): International Conference on Nutrition PP:27, FAO organization, US
9. ESN – Nutrition Country Profile (1991) : PP:9, FAO Organization, Iran

10. John Schieszer, 2018, Researchers Make Anaemia Discovery That May provide new targets for therapy, University of Virginia School of Medicine, Virginia 11. Ntutive App, 1991, <https://www.ntutive.in>
11. TNAU Agritech Portal, 2015, <https:// agritech.tnau.ac.in>
12. Mathew Bruce, 2003, www.internationaldrugmart.com.

APPENDIX

Appendix 1

Expert Evaluation

4.6.1.1 Organoleptic Evaluation of Beetroot Paratha with Raitha

Table 10:- Sensory Evaluation Table of Beetroot Paratha with Raitha

Name of the taster	Taste of the Recipe	Appearance of recipe	Aroma of recipe	Texture of the recipe	Overall rating	Average score
Ms.Nimmi Jacob	5	5	5	5	5	5
Dr. Shilpa Jose	5	5	5	5	5	5
Ms. Rose Mary Francis	5	5	4	4.5	4.5	4.5
Ms. Anu C.S	5	5	5	5	5	5
Dr. Leena Leon	5	5	5	5	5	5
Mean score	5	5	4.8	4.9	4.9	

- Mean scoring of all characteristics and overall rating was very good.
- Overall rating by 5 tasters was very good
- The average of evaluation scores of all 5 was between 4-5, which confirmed that the product was very good.

4.6.1.2 Organoleptic Evaluation Table of Lemon Rice with Potato Fry

Table 11:- Sensory Evaluation Table of Lemon Rice with Potato Fry

Name of the taster	Taste of the Recipe	Appearance of recipe	Aroma of recipe	Texture of the recipe	Overall rating	Average score
Ms.Nimmi Jacob	5	4	5	5	4.5	4.7
Dr. Shilpa Jose	4	4	4	4	4	4
Ms. Rose Mary Francis	4.5	4.5	5	5	4.5	4.7
Ms. Anu C.S	4	4	3	4	4	3.7
Dr. Leena Leon	4	5	4	5	4.5	4.5
Mean score	4.3	4.3	4.2	4.6	4.3	

- Mean scoring of all the characteristics was very good (4-5)
- Overall rating given by 3 was very good and 2 was good.
- The average of evaluation scores of all 5 was between 4-5, which confirmed that the product was very good.

4.6.1.3 Organoleptic Evaluation Table of Amaranth Dal with Rice

Table 12:- Sensory Evaluation Table of Amaranth Dal with Rice

Name of the taster	Taste of the Recipe	Appearance of recipe	Aroma of recipe	Texture of the recipe	Overall rating	Average score
Ms.Nimmi Jacob	4	5	5	4	4.5	4.5
Dr. Shilpa Jose	4	4	4	4	4	4
Ms. Rose Mary Francis	4	3.5	3	4	4	3.6
Ms. Anu C.S	4	3	3	4	4	3.5
Dr. Leena Leon	4	4	4	4	4	4
Mean score	4	3.9	3.8	4	4.1	

- Mean scoring of all characteristics was good (between 3-4)

- Overall rating by 5 tasters was good
- The average of evaluation scores of 1 was very good and 4 was good.

4.6.1.4. Organoleptic Evaluation Table of Egg Fried Rice with Dates Pickle

Table 13: Sensory Evaluation Table of Egg Fried Rice with Dates Pickle

Name of the taster	Taste of the Recipe	Appearance of recipe	Aroma of recipe	Texture of the recipe	Overall rating	Average score
Ms.Nimmi Jacob	-	-	-	-	-	-
Dr. Shilpa Jose	3	2	3	3	3	2.7
Ms. Rose Mary Francis	4.5	4	4	4.5	4.5	4.2
Ms. Anu C.S	5	4	4	4	4	4.2
Dr. Leena Leon	4	5	4	5	4.5	4.5
Mean score	4.1	3.7	3.7	4.1	4	

- Mean scoring of all characteristics was good (above 3)
- Overall rating by 3 tasters was very good and 1 one was good.
- The average of evaluation scores of all 4 tasters was good and 1 was satisfactory.

4.6.1.5 Organoleptic evaluation table of Bhindi Fry with Chapathi and Amaranth Dal

Table 14:- Sensory evaluation table of Bhindi Fry with Chapathi and Amaranth Dal

Name of the taster	Taste of the Recipe	Appearance of recipe	Aroma of recipe	Texture of the recipe	Overall rating	Average score
Ms.Nimmi Jacob	3	4	4	4	4.5	3.7
Dr. Shilpa Jose	5	5	5	5	5	5
Ms. Rose Mary Francis	3.5	3.0	3	3.5	3.5	3.3
Ms. Anu C.S	3	3	4	4	4	3.5

Dr. Leena Leon	4	3	4	4	4.5	3.7
Mean score	3.7	3.6	4	4.1	4.3	

- Mean scoring of taste, appearance and aroma of the product was very good. (3-5)
- Overall rating by 4 tasters was very good and 1 was good.
- The average of evaluation scores of all 5 was between 3-5, which confirmed that the product was very good.

4.6.1.6 Organoleptic Evaluation Table of Rice Flour Dosa with Tomato Chutney.

Table 15:- Sensory Evaluation Table of Rice Flour Dosa with Tomato Chutney

Name of the taster	Taste of the Recipe	Appearance of recipe	Aroma of recipe	Texture of the recipe	Overall rating	Average score
Ms.Nimmi Jacob	4	4	4	5	4.5	4.2
Dr. Shilpa Jose	3	3	3	3	3	3
Ms. Rose Mary Francis	4	4.5	4	4	4.5	4.1
Ms. Anu C.S	4	3	3	4	3	3.5
Dr. Leena Leon	4	4	4	5	4.5	4.2
Mean score	3.8	3.7	3.6	4.2	3.9	

- Mean scoring of all characteristics was good (between 3-4.5)
- Overall rating by all 5 tasters was good
- The average of evaluation scores of all 5 was between 3-4.5, which confirmed that The product was good.

Appendix 2

Nutritive Value of the Modified Lunch Box Recipes

Table 16: Nutritive Value of the Ingredients of Beetroot Paratha with Raitha

Ingredients	Weight (g)	Energy (k cal)	Protein (g)	Iron (mg)	Folic acid (mg)	VitA (mg)	Vit B12 (mg)	Vit C (mg)
Beetroot	50	17.81	0.98	0.38	48.69	0.85		2.63
wheat flour	50	160.29	5.29	2.05		0.23		
Drumstick leaves	5	3.37	0.32	0.23		146.18		5.4
Curd	30	18	0.93	0.06	0.99		0.04	0.3
Onion	10	5.66	0.18		2.97	0.11		1.1
Stem	5	7.93	0.19	0.33	2.65			2.66
Total		213.06	7.89	3.05	55.3	147.37	0.04	12.09

- It has good energy, moderate protein and Iron content.

Table 17: Nutritive Value of the Ingredients of Lemon Rice with Potato Fry

Ingredients	Weight (g)	Energy (k cal)	Protein (g)	Iron (mg)	Folic acid (mg)	VitA (mg)	Vit B12 (mg)	Vit C (mg)
Rice	50	182	9.5	3.15		15		2.1
Lime juice	10	3.66	0.04	0.01	1.24			4.82

Drumstick leaves	10	6.74	0.64			292.37		10.8
Potato	150	91.42	2.03		20.78			39.62
Onion	80	45.32	1.46		23.74	0.99		8.77
Total		329.14	13.67	3.62	50.05	308.36		66.11

- It has good energy, protein and Iron content.

Table 18: Nutritive Value of the Ingredients of Amaranth Dal with Rice.

Ingredients	Weight (g)	Energy (k cal)	Protein (g)	Iron (mg)	Folic acid (mg)	Vit A (mg)	Vit B12 (mg)	Vit C (mg)
Rice	50	182	9.5	3.15		15		2.1
Moong Dal	20	65.82	4.31	1.22	36.4	5.5		
Amaranth leaves	50	15.3	1.65	2.32	35.17	712.75		41.77
Tomato	50	13	0.82	0.59				4.65
Onion	80	45.32	1.46		23.74	0.99		8.77
Total		321.74	17.74	7.28	95.31			57.29

- It has good energy, moderate protein and good Iron content.

Table 19: Nutritive Value of the Ingredients of Egg Fried Rice with Dates Pickle.

Ingredients	Weight (g)	Energy (k cal)	Protein (g)	Iron (mg)	Folic acid (mg)	Vit A (mg)	Vit B12 (mg)	Vit C (mg)
Egg	50	84.3	6.57	0.82		104.55	0.9	

Rice	50	182	9.5	3.15		15		2.1
Onion	50	28.32	0.91		14.84			5.48
Dates	20	62.19	0.48	0.96	2.56	90.17		0.77
Total		356.64	17.64	4.93	17.4	209.72	0.9	8.35

- It has good energy moderate Protein and Iron content.

Table 20:- Nutritive Value of the Ingredients of Bhindi Fry with Stuffed Chapathi

Ingredients	Weight (g)	Energy (kcal)	Protein (g)	Iron (mg)	Folic acid (mg)	Vit A (mg)	Vit B12 (mg)	Vit C (mg)
Bhindi	200	54.97	4.16	1.68	127.36	23.03		45.02
Onion	100							
Wheat flour	100	320.57	10.57	4.1		0.45		
Cheera	50	15.3	1.65	2.32	35.17	712.75		41.77
Tomato	25	6.5	0.41	0.3				2.33
Drumstick leaves	5	3.37	0.32	0.23	2.14	146.18		5.4
Total		400.71	17.11	8.63	164.67	882.41		94.52

- It has high energy, good Protein and Iron content.

Table 21- Nutritive Value of the Ingredients of Ragi Dosa with Tomato Chutney.

Ingredients	Weight (g)	Energy (k cal)	Protein (g)	Iron (mg)	Folic acid (mg)	VitA (mg)	Vit B12 (mg)	Vit C (mg)
Rice flour	100	364	19	6.3		30		4.2
Ragi	50	160.37	3.58	2.31	17.33	0.13		
Tomato	50	13	0.82	0.59				4.65

Onion	20	11.33	0.36		5.94	0.22		2.19
Drumstick leaves	10	6.74	0.64	0.46	4.29	292.37		10.8
Total		555.44	24.4	9.66	27.56	322.72		21.84

- It has good energy, Protein and Iron content

Comparison of Original Lunch Box Recipes with Modified Lunch Box Recipes

In Beetroot Paratha with Raitha, there is a increase in Energy, Protein, Iron, Folic acid and Vitamin C level in Modified Lunch Box Recipes compared to Original Lunch Box Recipes.

In Lemon Rice with Potato Fry, there is a increase in Energy, Protein, Iron, Folic acid, Vitamin A and Vitamin C level in Modified Lunch Box Recipes compared to Original Lunch Box Recipes.

In Amaranth Dal with Rice there is no change.

In Egg Fried Rice with Dates Pickle there is no change

In Bhindi Fry With Stuffed Chapathi, there is a increase in Energy, Protein, Iron, Folic acid, Vitamin A, Vitamin B12 and Vitamin C in Modified Lunch Box Recipes compared to Original Lunch Box Recipes.

In Ragi Dosa with Tomato Chutney, there is a increase in Energy, Protein, Iron, Folic acid, Vitamin A, Vitamin B12 and Vitamin C in Modified Lunch Box Recipes compared to Original Lunch Box Recipes.

Appendix 3

Adolescent Evaluation

4.6.2.1 Organoleptic Evaluation of Beetroot Paratha with Raitha.

Table 22:- Sensory Evaluation Table of Beetroot Paratha with Raitha

Name of the taster	Age	Taste of the Recipe	Appearance of recipe	Aroma of recipe	Texture of the recipe	Average score
A	15	3.1	4	3.5	3	3.4
B	13	3	4.1	3.1	3.4	3.4
C	17	3.5	4.3	4	3.6	3.8
D	14	3	4	3.8	3.8	3.6
E	16	2.9	4.2	3.6	2.6	3.3
Mean scores		3.1	4.1	3.6	3.28	

- Mean scoring of appearance was very good (4.1) and that of other characteristics and overall rating was good (above 3)
- Overall rating by 2 tasters was good and 3 was very good.
- The average of evaluation score of all 5 was between 3-4, which confirmed that the product was good.

4.6.2.2 Organoleptic Evaluation of Lemon Rice with Potato Fry

Table 23:- Sensory Evaluation Table of Lemon Rice with Potato Fry

Name of the taster	Age	Taste of the Recipe	Appearance of recipe	Aroma of recipe	Texture of the recipe	Average score
A	15	3.8	4	3.8	3.2	3.7
B	13	4.1	3.3	3.7	3.1	3.5
C	17	3.5	4.2	4.2	3.3	3.8
D	14	3.6	3.6	4.3	3.5	3.8
E	16	4	3.8	3.8	3	3.6
Mean scores		3.8	3.7	3.9	3.2	

- Mean scoring of all the characters was good (between 3-4).
- Overall rating given by 1 taster was very good and 4 was good.

- The average of evaluation scores of all 5 was between 3-4, which confirmed that the product was good.

4.6.2.3 Organoleptic Evaluation Table of Amaranth Dal with Rice

Table 24:- Sensory Evaluation Table of Amaranth Dal with Rice

Name of the taster	Age	Taste of the Recipe	Appearance of recipe	Aroma of recipe	Texture of the recipe	Average score
A	15	3.3	4.2	4.1	3.6	3.8
B	13	3.8	4	3.7	3.8	3.8
C	17	3.3	4.1	4	3.5	3.7
D	14	3.6	3.9	4.3	3.8	3.9
E	16	3.5	4	3.9	4	3.8
Mean scores		3.5	4	4	3.7	

- Mean scoring of appearance and aroma was very good and that of other characteristics was good (above 3)
- Overall rating by 5 tasters was very good.
- The average of evaluation scores of 4 was good and one was very good.

4.6.2.4 Organoleptic Evaluation Table of Egg Fried Rice with Dates Pickle

Table 25:- Sensory Evaluation Table of Egg Fried Rice with Dates Pickle

Name of the taster	Age	Taste of the Recipe	Appearance of recipe	Aroma of recipe	Texture of the recipe	Average score
A	15	3.1	3.8	3.5	4.1	3.6
B	13	4.1	3.7	4	4	3.9
C	17	3.7	3.9	4	3.6	3.8
D	14	3.1	3.2	3.7	3.6	3.4
E	16	4	4.1	3.8	4.2	4

Mean scores		3.6	3.7	3.8	3.9	
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- Mean scoring of all characteristics was good (above 3)
- Overall rating by all 5 tasters was good.
- The average of evaluation scores of 3 was good and 2 was very good.

4.6.2.5 Organoleptic Evaluation Table of Bhindi Fry with Stuffed Chapathi

Table 26:- Sensory Evaluation Table of Bhindi Fry with Stuffed Chapathi

Name of the taster	Age	Taste of the Recipe	Appearance of recipe	Aroma of recipe	Texture of the recipe	Average score
A	15	4.1	4.2	4	4	4
B	13	4.2	4.3	4.3	3.9	4.1
C	17	4	4	4.4	3.7	4
D	14	4.3	3.8	4.2	3.8	4
E	16	4.5	3.9	4.3	4	4.2
Mean scores		4.2	4	4.2	3.8	

- Mean scoring of taste appearance and aroma of the product was very good (≥ 4).
- Overall rating by all 5 tasters was good.
- The average of evaluation scores of all 5 was ≥ 4 , which confirmed that the product was very good.

4.6.2.6 Organoleptic Evaluation Table of Ragi Dosa with Tomato Chutney

Table 27:- Sensory Evaluation Table of Ragi Dosa with Tomato Chutney .

Name of the taster	Age	Taste of the Recipe	Appearance of recipe	Aroma of recipe	Texture of the recipe	Average score
A	15	4	4	3.5	3.6	3.8
B	13	4.2	4.1	3.6	3.8	3.9

C	17	4.4	4	3.5	3.5	3.9
D	14	4	4.2	3.7	3.5	3.8
E	16	4.3	3.9	3.8	3.6	3.9
Mean scores		4.1	4	3.6	3.6	

- Mean scoring of taste and appearance was very good (above 4) and that of the other characteristics was good (above 3)
- Overall rating by all 5 tasters was good and mean score of overall rating was very good.
- The average of evaluation scores of all 5 was between 3-3.9, which confirmed that the product was good.