

CHAPTER 1

INTRODUCTION

1.1 Background Study

Anaemia is a pathological condition in which the haemoglobin (Hb) concentration in red blood cells is abnormally low. The terms anaemia, iron deficiency (ID), and iron deficiency anaemia (IDA) are sometimes used synonymously and interchangeably (WHO, 2001). It is known that ID is the common cause of anaemia in the world (Alférez *et al.*, 2006). IDA is characterized by the reduction or absence of iron (Fe) stores, low serum Fe concentration, poor Hb concentration, haematocrit reduction and increased platelet count. The most affected group include pregnant women, preschool and school-age children, low birth weight infants and women of childbearing age (WHO, 2008). IDA is a major public health problem affecting both developing and developed countries (Viteri, 1993; Pourghassem *et al.*, 2000), including Malaysia (National Health and Morbidity Survey, 2019). The World Health Organization (WHO) in 2008 estimated that 24.8% of the world's population is affected by iron deficiency and anaemia.

In Malaysia, the overall prevalence of anaemia was 21.3%. Prevalence of mild, moderate and severe anaemia was 13.5%, 6.8% and 1.0% respectively. When analyzed by gender, females exhibited a higher prevalence of anaemia at 30.4% compared to males at 12.6%. Considering the urban-rural area, the prevalence of anaemia was slightly more prominent in rural areas at 22.9% in contrast to the

20.9% in urban regions. By ethnicity, Indians had the highest prevalence at 26.7%. Among the states, Kelantan displayed the highest anaemia prevalence rate of 27.2%. The prevalence of anaemia was highest among those with monthly household income of less than RM1000 at 29.6% and those with no formal education at 28.4%. Among women of reproductive age group, the prevalence of anaemia was 29.9%. The prevalence of mild anaemia among women of reproductive age group was 15.9% whilst moderate and severe anaemia was 14.0% (National Health and Morbidity Survey, 2019) .

Anaemia appears to be a significant public health problem with regards to iron deficiency. The main reason for the poor iron status is the inadequate intake and low bioavailability of dietary iron as well as poor intake of other nutrients (Foo *et al.*, 2004). It brings major consequences to human health, effects on children development and growth and increased mortality of infants younger than 2 years, as well as impaired social and economic development. IDA also has negative effects on work capacity in adults and on motor also mental development in infants, children and adolescents. Grantham-McGregor & Ani in 2001 also reported that IDA affects fertility, as well as increased mortality in pregnant women and the elderly.

Iron is a chemical element with the atomic number 26 and the symbol Fe. It is crucial to human biology because it forms complexes with the molecule oxygen in myoglobin and haemoglobin. In vertebrates, these two substances are typical oxygen transport proteins. Numerous significant redox enzymes involved in cellular respiration, oxidation, and reduction in both plants and animals also utilize this mineral at their active sites. A vital trace element called iron is present in almost

all living things. Many biological oxidations and transport processes involve iron-containing enzymes and proteins, which frequently contain heme prosthetic groups. Haemoglobin, cytochrome, and catalase are a few examples of proteins found in higher species (Lippard *et al.*, 1994). Due to their low cost and wide availability, fruits and vegetables are superior to dietary supplements as significant providers of nutrients. Fruits and vegetables are closely linked to a lower risk of iron deficiency when consumed daily. Iron is a crucial part of haemoglobin, and getting enough of it through fruits and vegetables is necessary for health (Eldaim & Elnadi, 2014).

To prevent ID, vulnerable populations should be encouraged to consume iron-rich foods and breastfeed or use the iron-fortified formula for infants. Based on the Al-Quran and Prophetic Sunnah, dates and goat milk are considered the superfood for the preservation of health. The holy Quran clearly stated these in Surah An-Nahl: “And indeed, for you in grazing livestock is a lesson. We give you drink from what is in their bellies – between excretion and blood – pure milk, palatable to drinkers.” (Al-Quran 16:66) and “And from the fruits of the palm trees and grapevines you take intoxicant and good provision. Indeed in that is a sign for a people who reason.” (Al-Quran 16:67). Besides that, a hadith narrated by ‘Aisha reported that the prophet SAW as saying, “The Ajwah dates of al-aliya contain healing effects and they are a remedy when taken first thing in the morning” (Sahih Muslim 23/5083). This is supported by the numerous scientific studies which reported that dates and goat milk are rich sources of many nutrients and are able to alleviate symptoms of IDA (Alfe’reza *et al.*, 2006; Abdel Rahman, 2006; Onuh *et al.*, 2012; Abdelsalam *et al.*, 2014).

One of the oldest plants that mankind has ever cultivated, dates (*Phoenix dactylifera*), have been consumed as food for more than 6000 years (Amer, 1994). Due to its nutritional, health, and economic worth, it might be used for many generations. Dates present promising opportunities for battling hunger and disease. The Quran has more than 20 mentions of dates, which are the most significant traditional crop in Iraq, Turkiye, Morocco and Arabia. Dates are a customary first meal during Ramadan in Islamic nations after the sun goes down (Eldaim & Elnadi, 2014). In most of the hot, arid, and semi-arid regions of the world, dates palm play a significant role in the diet. It is rich in iron (Sulieman, 2012; Eldaim & Elnadi, 2014) and was reported to increase the Hb level in rats (Onuh *et al.*, 2012; Zen *et al.*, 2013). Dates have also been described as a major source of Fe among fruits (Sahari *et al.*, 2007).

Dates are a nutrient-dense meal that is high in energy and a good source of carbohydrates that are easily absorbed by humans. They also contain a number of nutrients that are necessary to sustain human health (Al Farsi *et al.*, 2005). It is also a significant source of dietary fibres, certain essential vitamins and minerals (Al Shahib & Marshall, 2003). Moderate concentrations of manganese, iron, phosphorus and calcium per 100 g of dates provide over 7% of the daily Recommended Dietary Allowances and Adequate Intakes (Al-Farsi & Lee, 2008). Due to insufficient food intake, diets in underdeveloped nations typically lack several nutrients, especially energy. Due to inadequate intake of a nutritious diet, mineral and vitamin deficiencies are also quite prevalent in developing countries (Vayalil, 2012). Date consumption would significantly contribute to the daily needs for many of these nutrients, including carbohydrates, minerals (such as iron,

magnesium, calcium, zinc, potassium, copper, and selenium), and a good source of vitamins (such as niacin, B6, and folate) (Vayalil, 2012). Therefore, daily consumption of dates may be a good alternative for the treatment of nutritional deficiency-related diseases such as anaemia, goiter, rickets and osteomalacia. Furthermore, dates served as a nutritional supplement for disorders like osteoporosis, arthritis, multiple sclerosis, cancer, cataracts and age spots by adding minerals like calcium, copper, selenium and potassium for the body's requirements (Vayalil, 2012). The date pits are also an excellent source of dietary fibre and have significant amounts of protein, lipids, and minerals (Baliga, 2011). The dates were also beneficial in anaemia and digestive disorders, facilitates childbirth and soothing postpartum pains and excessive menstrual flow (Rivera *et al.*, 2014). Besides these, dates also increase the level of red blood cells, haemoglobin, reticulocytes and platelet counts (Onuh *et al.*, 2012; Zen *et al.*, 2013; Abdelsalam *et al.*, 2014).

One of the earliest animals to be domesticated by humans was the goat, which happened roughly 10,000 years ago. In several countries throughout the Middle East, Europe, Oceania, and Asia, dairy goat and sheep farming has developed into a crucial economic sector. Numerous proceedings and conferences have covered and proven the value of goats as a source of meat and dairy products in those areas (Yangilar, 2013). It is advantageous for both children's and senior people's nutritional needs as well as their physical health. Additionally, the nutritional and economic health of developing and underdeveloped nations are significantly impacted by goat milk (Yangilar, 2013).

The natural food source known as goat milk is well known for its superior nutritional qualities. Goat milk, on average, includes 12.2% total solids, 4.1% lactose, 3.8% fat, 3.5% protein, and 0.8% ash. These findings show that while it delivers an equivalent number of calories for human nutrition as either cow or human milk does, it has more protein, fat and ash and less lactose than cow milk (Park, 2006). Fatty acids, including caprylic, caproic and capric are found in goat milk. They were believed to provide excellent medical benefits for treating anaemia, gallstones, cystic fibrosis and paediatric epilepsy (Haenlein 1992; Alfe'reza *et al.*, 2006).

Children who consumed goat milk gained more weight, height, bone mineralization, calcium, thiamin, riboflavin, blood serum vitamin A, niacin, and haemoglobin content than children who consumed cow milk, indicating that goat milk provides adequate levels of vitamin A, thiamine, riboflavin, and pantothenic acid (Daz-Castro *et al.*, 2015). However, it was discovered by Jenness (1980), Jauber & Kalantzopoulos (1996), and Park (2006) that goat milk lacks iron, vitamins B6, B12, C, and D, as well as folic acid.

According to research by Alfe'reza *et al.* (2006), the high calcium content of milk and other dairy products from cows prevents the body from absorbing iron from food. However, according to recent research, goat milk has better Fe bioavailability than cow milk, and it also reduces the interference of Fe absorption by enhancing Ca metabolism and digestion (Barrionuevo *et al.*, 2002; López-Aliaga *et al.*, 2008) and reducing the possibility of interactions between Fe and other minerals like Ca, P, and Mg (López-Aliaga *et al.*, 2000).

1.2 Rationale of The Study

Preservation of health among the poor remains a worldwide challenge. To preserve health, the diet should contain sufficient amounts of essential nutrients that can provide solutions to the problem of malnutrition and anaemia. However, being far from the city and the cost of nutritious food renders it inaccessible to the poor. Therefore, the challenge to combat this problem is to find wholesome and natural food that is highly nutritious and affordable for the poor.

It is well understood that dates and goat milk are complete foods for survival which is rich in iron and can alleviate symptoms of anaemia. Many studies focused on the biochemical properties and the improvement of the haemopoietic activity with the use of dates and goat milk. There is a report on the iron bioavailability study of dates and goat milk. Iron bioavailability is affected by the composition of the food, including the presence of inhibitory and enhancing factors for iron absorption. However, recent studies have found that goat milk not only increase Fe bioavailability in anemic rats but also minimizes the interference of Fe absorption by improving the metabolic and digestion of Ca. Therefore, this study will focus on the assessment of iron bioavailability in dates and goat milk using Caco-2 cell lines. We will also study the beneficial effects of dates and goat milk on IDA human subjects.

1.3 Objective of The Study

General objective

To investigate the beneficial effects of dates (*Phoenix dactylifera*) and goat milk in iron deficiency anaemia.

Specific objectives

- a) To determine the effects of dates and goat milk in alleviating iron deficiency anaemia using systematic review.
- b) To analyse the nutritional content of dates (Ajwa and Mariami) and goat milk using High Performance Liquid Chromatography.
- c) To measure iron bioavailability from dates extract (Ajwa and Mariami), goat milk and a mixture of date with goat milk using Caco-2 cell model.
- d) To investigate the effects of Ajwa dates and goat milk on haemopoietic activity in iron deficiency anaemia subjects using haematological analysis.
- e) To determine the effects of Ajwa dates and goat milk on iron profile in iron deficiency anaemia subject using iron profile analysis.

1.4 Research Hypothesis

- a) Mixture of dates and goat milk increase iron bioavailability
- b) Combination of dates and goat milk supplement improve haemopoietic activity in iron deficiency anaemia subject
- c) Combination of dates and goat milk supplement increase iron store in iron deficiency anaemia subject.