Role of Beet Root Juice in Management of Anaemia: A Descriptive Review

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***Abstract*—According to current therapeutic approaches, beet root juice (BRJ) is postulated as a nutritional strategy that might help prevent or treat mild to moderate anemia in adolescent girls, menstruating women and pregnant mothers. The 18 Published articles that met the inclusion criteria, which includes 14 clinical trials and 4 comparative studies from Google Scholar and PubMed was conducted to identify studies examining the relationship between BRJ and anemia. The review was able to demonstrate that BRJ supplementation is a cost-effective strategy that might treat or prevent anemia in different populations, probably through increased iron absorption in small intestine and presence of pigment called betanin, vitamin C, Folic acid and iron content found in Beta vulgaris. This easily found and cost-effective dietary intervention could significantly reduce the incidence and treat anemia in the given population. Hence, BRJ supplementation should be promoted as a key component of healthy lifestyle in women of reproductive age group to prevent anemia and its associated morbidities. However, intense studies to be done regarding BRJ intake (e.g., secondary metabolites present in Beta vulgaris, its safe amount of intake in patients with urolithiasis, etc.).**

***Keywords*—beet root juice, red beet, Beta vulgaris, anaemia/anemia.**

I. Introduction:

The WHO defines anaemia as having a haemoglobin (Hb) concentration below 12 g/dL [1]. A complicated aetiology involving both nutritional and non-nutritional components underlie the multifactorial nature of anaemia [2]. Anaemia affected 32.9% of the world's population, according to estimates from 2010 [3]. (1) Children under 5 years old (42% had anemia in 2016), notably newborns and young children under 2 years old, (2) Pregnant women (46% anaemia in 2016) and (3) women of reproductive age (WRA) (39% anaemia in 2016) are among the population categories most at risk for anaemia [4][5]. In practically all age categories and geographic areas, women consistently had a higher anaemia risk than men did [3]. According to the 2016 global nutrition survey, India is ranked 170th out of 180 nations for the prevalence of anaemia in women [6]. Around the world, ID accounts for around 50% of cases of anaemia, making it the most prevalent cause [7].

Based on its appearance and pathogenesis, anaemia can be categorised. Anaemias are divided into three categories based on the pathophysiologic mechanism: anaemia owing to blood loss, anaemia due to decreased red cell production, and anaemia due to increased red cell apoptosis. Red cell size, haemoglobin content, and red cell indices are used to categorise anaemias morphologically into three groups: macrocytic, normocytic, and microcytic hypochromic. [8]. Iron, Vitamin A, Vitamin B12, Folate, and Riboflavin Deficiency Anaemias are the several types of nutritional anaemias. The most typical type of anaemia in the world is iron-deficiency anaemia (IDA) [9]. When dietary iron intake is insufficient over time, especially during times of high iron demand (e.g., during periods of rapid growth and development, such as infancy and pregnancy), or when iron losses outweigh iron intake, ID occurs. Storage iron depletion, iron-deficient erythropoiesis, and IDA (defined as concomitant ID plus anaemia) are the three stages that ID normally progresses through [10]. Iron deficiency (ID) can cause a wide range of additional signs in addition to anaemia. IDA is most likely to be diagnosed when a complete blood count (CBC) shows hypochromia and microcytosis [11]. For biological processes like respiration, oxygen transport, DNA synthesis, energy production, and cell proliferation, iron is essential. [12].

Severe anaemia complications include difficulties carrying out routine duties [13]. Anaemia from a folate shortage during pregnancy increases the risk of problems including preterm delivery and congenital defects in the baby [14]. Arrhythmia can also result from anaemia. The heart of anaemic individuals pumps extra blood to make up for the blood's lack of oxygen. Heart failure or cardiac enlargement may result from this [15]. Anaemia is linked to an increased risk of death, especially in elderly adults with severe anaemia [16]. Currently, oral iron supplements are the first line of treatment for IDA patients. Iron supplementation may become necessary in patients whose gastrointestinal blood loss exceeds their intestinal capacity to absorb iron. In these circumstances, IDA can be managed with intravenous iron supplementation [17]. Supplementing with vitamin A has been demonstrated to be effective in the fight against IDA [18]. B-vitamin therapeutic supplementation is often only required in cases of insufficiency. In the presence of an appropriate nutritional intake, they offer no further advantages [19].

It has long been understood that there is a direct link between the food we eat and our health. Diet therapy is a general word for changing or adopting a diet to either promote or treat an illness, or to simply maintain good health. Diet therapists often do a medical history and current health status evaluation of their patients before prescribing a tailored diet plan and providing appropriate advice [20].

The term 'functional food' was coined in Japan in the early 1980's [20]. Functional foods are organic, bioactive chemicals that have therapeutic, disease-prevention, or health-promoting qualities [21]. Foods that, in addition to their nutritional content, have a

favourable effect on a person's health, physical performance, or mental state are referred to as functional foods [22]. The beetroot has drawn more attention in recent years due to its powerful biological activity and several health advantages [23].

A member of the Chenopodiaceae family is the beetroot, Beta vulgaris. The many grown kinds of which the most well-known is the purple root vegetable known as beetroot or table garden beetroot are what are best known about it [24]. The beetroot is a root vegetable with variegated leaves that are purple and green. Either it is a small, circular taproot or, in the case of sugar beetroot, a long, carrot-like root with few secondary roots [25]. Typically, beets' dark purple roots are consumed raw, roasted, or boiled, either on their own or in combination with other salad ingredients. The beet's leafy, green exterior can be eaten as well. Low in fat but high in carbs, starch, soluble fibres, and proteins, beetroot is a vegetable with a modest caloric value [26]. The vitamins C, A, E, and K are abundant in beets. In addition to folic acid and potent antioxidants such triterpenes, sesquiterpenoids, carotenoids, coumarins, flavonoids, betalains, and phenolic compounds, they contain significant amounts of B-vitamins (B1, B2, B3, B5, B6, B9, and B12) [27, 28]. Minerals including manganese, magnesium, potassium, sodium, iron, phosphorus, zinc, copper, boron, silica, and selenium are also abundant in them [29].

Table 1. Composition of raw red beetroot flesh per 100 g [30]

Compounds	Value	
	Tubers	Leaves
Water (g)	91.3 ± 4.29	91.00 ± 4.00
Protein (g)	1.89 ± 0.3	2.20 ± 0.5
Carbohydrate, by difference (g)	7.23 ± 2.33	4.33 ± 1.5
Fiber, total (g)	3.25 ± 0.55	3.7
Sugars, total (g)	6.76 ± 1.23	0.50
Total lipid (fat) (g)	0.15 ± 0.05	0.13
Ash (g)	1.08 ± 0.72	2.33
α-Carotene (µg)	22.0 ± 2.0	3.5 ± 0.5
β-Carotene (µg)	0	11.64
Lycopene (µg)	30 ± 0.3	0
Betaine (µg)	128.7 ± 22.0	0
Lutein + zeaxanthin (µg)	0	1.503
Folate (µg)	109	15
Niacin (mg)	0.334	0.400
Vitamin A, IU	0	6.326
Vitamin B_6 (mg)	0.067	0.106
Vitamin C (mg)	7.2 ± 2.5	30
Sodium, Na (mg)	78.0 ± 5.0	226
Potassium, K (mg)	325 ± 4.5	762
Phosphorus, P (mg)	40.00	41
Magnesium, Mg (mg)	23.0 ± 2.0	70
Calcium, Ca (mg)	16 ± 3.5	117
Manganese, Mn (mg)	0.359 ± 0.04	0.391
Zinc, Zn (mg)	0.365 ± 0.015	0.38
Copper, Cu (mg)	0.075	0.191
Iron, Fe (mg)	0.80	2.57

Betalains: It is a special kind of nitrogen-containing pigment that is only present in Caryophyllales order families and some higher order fungi [31]. Beta vulgaris betalains are divided into two classes: yellow betaxanthins and red, violet, and blue betacyanins. Betanin is the main betalain in red beetroot [32]. Beets have a relatively high antioxidant capacity when compared to other vegetables. Antioxidant capability and the presence of red pigment were shown to be substantially correlated [33].

Betaine: (trimethylglycine): The majority of living things contain betaine (trimethylglycine), and abundant dietary sources include shellfish [34]. Betaine's main physiological function is as a methyl donor (transmethylation) and osmolyte [35]. Homocysteine, a critical component in the cascade development of atherosclerosis, is mostly reduced by betaine [36].

Nitrates: Nitrates from red beets are currently regarded as one of the most essential nutrients. Nitrates often have ergogenic and cardioprotective effects. Blood pressure reduction and vasoprotection are caused by bioconversion of beta vulgaris nitrates to nitrite and nitric oxide [37].

Oxalates: Beetroot has a lot of oxalates and might have negative consequences. The oxalate-accumulating plant family includes red beetroot. Red beetroot eating is thus not recommended for those with urolithiasis [38].

The water-soluble vitamins C, A, and folic acid, as well as the trace elements iron, copper, and zinc, are all abundant in beets. In the treatment and prevention of anaemia, these minerals are extremely important. In people who are anaemic, beetroot is more affordable and a safer option than iron pills. The current study examines how BRJ use affects anaemia, particularly IDA. Women in India who are of childbearing age are more likely to get IDA. Thus, women in this age bracket are the primary subject of the study.

I. Methodology:

The online databases, Google Scholar, PubMed were searched for citations with keywords “beet root juice (BRJ)”, “red beet”, “beta vulgaris”, “anaemia/anaemia”. The search yielded total of 213 references from the date of inception. Experimental studies in English, revealing the effects of beetroot juice/beetroot extract in anaemia were included in the review. The studies having only abstracts, the studies on BRJ supplementation in sports performance and effect of beetroot in other diseases were excluded. A total of 18 studies were selected for the final review, which includes 14 clinical trials and 4 comparative studies. The present review is conducted to find out effect of BRJ on anaemia.

II. Result:

Out of a total of 60 teenage girls, 30 girls were in the experimental group and 30 girls were in the control group, Experimental group received the freshly produced beetroot juice for 20 days at mid-morning. Compared to the control group, showed a significantly significant improvement in haemoglobin level after receiving beetroot juice (p 0.001) [39]. The study found that beetroot juice and jaggery are effective in raising haemoglobin levels because they caused improvements in haemoglobin levels in the experimental group compared to the control group in the teenage girls [40]. The study demonstrated that students who received beetroot juice early on had higher levels of Hemoglobin (Hb) in terms of having normal menstrual cycles, healthy conjunctiva and nails, and no correlation between beetroot juice administration and any selected variable [41].

The post-test results for beetroot juice with jaggery's efficacy on iron deficient anaemia showed an increase in Hb level. Out of 40 samples, 6 (or 15%) had normal haemoglobin levels, 14 (or 35%) had mild iron deficiency anaemia, 16 (or 40%) had moderate anaemia, and 4 (or 10%) had severe anaemia. The mean difference was 0.757, the pre-test standard deviation was 1.078, the post-test standard deviation was 1.149, the standard error was 0.071, and the t-test result was 8.703 which showed significant at p0.001 [42]. After 30 days, both therapies show an increase in total RBC and haemoglobin (Hb) content. On day 60, both the Beetroot and Prickly Pear groups had significantly increased mean haemoglobin contents and total RBCs (11.140.32 gm% and 9.250.39 1012/L, respectively; p 0.001). Betacyanin may be responsible for erythropoiesis, and the current amount is safe for long-term usage. Beetroot root and prickly pear have a traditional use as haematinics. Even though prickly pear has less betacyanin than beetroot root, it nonetheless has a more effective effect on erythropoiesis [43].

In this study, the haemoglobin levels of female volunteers' blood samples were measured before and after they consumed 8 g of beetroot (Beta vulgaris L.) daily for 20 days. The findings revealed a little rise in haemoglobin levels, a fall in total iron binding capacity (TIBC), a rise in ferritin, and a rise in transferrin. After consuming beetroot, serum iron levels also slightly increased. MCV only showed a little rise in four volunteers. To maximise the performance advantages of beetroot, additional study is necessary to pinpoint the mechanisms of action and appropriate dose regimens [44]. The study's results indicate that the overall mean haemoglobin score prior to testing was 10.04 with a standard deviation of 0.58 and the overall mean haemoglobin score following testing was 12.67 with a standard deviation of 0.99. It revealed that the haemoglobin level of teenage females significantly improved following the administration of beetroot juice, with a "t"value of 17.787 at p=0.001. According to the results of the current study, beetroot root extract can effectively cure anaemia and raise haemoglobin levels in students who are anaemic [45].

The inclusion requirements were met by sixty teenage females, who were chosen using a non-probability convenient selection approach. The sociodemographic profile of the teenage females was employed as one of the study's techniques, and Taliques blot paper was used to measure the amount of haemoglobin. Experts in the relevant field validated the tool, and the reliability was evaluated using the test-retest method. Haemoglobin levels were measured before and after the administration of beetroot juice. After the administration of beetroot juice, the data analysis showed that there was a significantly higher level of haemoglobin among the teenage girls (p 0.05). The amount of haemoglobin did not significantly correlate with the demographic factors that were chosen [46]. The method of research employed was quantitative. By using simple random selection, 60 teenage females with iron deficiency anaemia were assigned to a quasi-experimental pretest-posttest design. The outcome shown that there is a highly significant (p0.001***) difference in the serum iron and CBC levels between the experimental and control posttests. It demonstrates that teenage girls' serum iron and CBC levels significantly improved following the consumption of beetroot juice with at (p0.001***). Clinical characteristics of the experimental group's posttest mean were 2.47 (SD 2.53), while those of the control group's posttest mean were 5.87 (SD 2.08). The study showed Beetroot juice was beneficial in treating teenage females with iron deficient anaemia [47].

A sample of 30 instructors who participated in the study and drank the Beta Vulgaris and Amaranthus Tricolour L juices for 14 days employed a complete sampling methodology. The findings demonstrated that consumption of Beta vulgaris juice and Amaranthus tricolour L juice significantly boosted haemoglobin levels by 1.03 g/dL and 1.34 g/dL, respectively. So, it is advised to people to frequently take either Beta Vulgaris juice or Amaranthus Tricolour L juice regularly to benefit from its consumption in raising Hb levels [48]. The Hb level significantly increased, while mean corpuscular volume (MCV), Mean Corpuscular Hemoglobin (MCH) and Mean corpuscular Hemoglobin concentration (MCHC) slightly improved at $p<0.001$ after the consumption of beetroot juice [49].

Nine anaemic individuals were chosen for the investigation. For three weeks, the group received a beetroot juice combination twice each day. The Hb level significantly increased, while MCV, MCH, and MCHC showed just a modest improvement. It demonstrates how beetroot juice may treat anaemia and raise Hb levels more quickly and effectively. Since beetroot juice immediately raises haemoglobin levels and other hematocrit indicators, it can be used as an alternative to hematinics. They also have no negative effects, even when used for months at a time [50]. consumption of 250ml of beetroot juice shows substantial increase in Hb level and small improvements or changes in MCV, MCH, and MCHC were noticed in patients who took beetroot juice compared to patients who consumed dates when given 125ml twice a day, at midday and in the evening. Thus, we may draw the conclusion that

dates and beetroot juice both consistently have a positive impact on the management of anaemia [51]. Pregnant women with anaemia were given 8 grams of beetroot powder daily for 14 days along with Fe (Iron) pills may raise erythrocyte counts, hematocrit levels, and haemoglobin levels [52]. Prior to intervention, this study's frequency distribution data indicated that mild anaemia prevalence was 46.7% and moderate anaemia prevalence was 53.3%. The value of p = 0.000 (p 0.05) was derived based on the findings of the Paired Sample T-Test shown the Juice from the beta vulgaris L (beetroot) plant can help an anaemic individual's Hb levels rise. 30 pregnant ladies made up the study's population [53].

In this study, Hb levels increased following two weeks of beetroot juice intervention for anaemic teenage females and two weeks of red spinach juice intervention as well. Hb values of anaemic teenage females after drinking beetroot and red spinach juices (p 0.05) The rise in Hb levels was statistically significant [54]. For seven days, 200 ml of beetroot juice each day is drank in order to eat 60 g of beetroot. Result showed that teenage girls attending an Islamic boarding school had significantly lower haemoglobin levels before and after receiving beetroot juice (p=0.001). Beetroot juice consumption causes a rise in haemoglobin levels in teenage females [55]. In a randomized controlled trial of a total of 60 adolescent girls, 30 girls in the experimental group received freshly made beetroot juice for 20 days in the middle of the morning. Utilising both descriptive and inferential statistics, the data was then analysed. In compared to the control group, samples in the experimental group demonstrated a highly significant increase in haemoglobin levels after the administration of beetroot juice (p 0.001). By doing this, anaemia in teenage females can be avoided, as well as difficulties caused by anaemia in the future [56].

Table 2: The Literature review of effect of Beetroot on Anemia patients

Sl no.	Title	Author	Intervention	Variables	Results
1	Beet root juice on haemoglobin among adolescent girls	N. Gayathri, M. Malarvizhi, Annal Jega Jothi, 2020	The freshly prepared beetroot juice was administered to the samples for 20 days in mid-morning.	Cyanmethemoglobin method	It showed that after the administration of BRJ, there was a high significant improvement in the Hb level of adolescent girls with a "t" value of 17.787 at p=0.001.
2	A Study To Evaluate The Effectiveness Of Beetroot Extract with Jaggery In Improving The Level Of Hemoglobin Among Late Adolescent Girls With Anaemia	Lizy Merlin Lisha	100 ml of beetroot extract was given for 7 days for the experimental group.	Digital Hemoglobin meter	The finding showed that there was a significant improvement in level of haemoglobin at p<0.05 among experimental group who were administered beetroot extract.
3	A Study to Assess the Effectiveness of Beetroot Juice on Hb Level Among Middleage Women in Sree Balaji Teacher Training Institute, Chennai	G.Manjulavathi	Samples were visited every day in their class and made to consume BRJ continuously for 20 days.	Sahli's hemometer	Highly significant result was found with the difference in pre-test and post-test mean being 1.2 (P<0.001) after giving Beetroot juice.
4	Study to assess the effectiveness of beetroot juice with jaggery on anaemia among adolescent girls in the selected urban area at Rajkot	Rupal Patel, Francis Luke, K Doss	Freshly prepared BRJ with jaggery was administered to the sample for 10 days.	Sahli's Hemoglobinometer	The study concluded that there was a significant increase in Hb levels at p<0.001 among the sample who were given the intervention.
5	Clinical evaluation of Beet root and Prickly pear in the management of Anaemia: An Observational Study	Sanjay Chauhan, Tejal Gopani, Bhanubhai Suhagia, Shivenarain Gupta, Kalapi Patel, Manish Patel	Group I patients received beet root capsule (500 mg) and group II, prickly pear capsule (500 mg), administered orally three times daily after meal for 60 days without mentioning special diet.	Sahli's Hemoglobinometer and complete blood count	Increase in Hb content and total RBC in both treatments after 60 days (p<0.001).
6	Effect of red beetroot (Beta vulgaris L.) intake on the level of some hematological	Nora M. Al-aboud	Seven apparently healthy female volunteers received oral dried beetroot 20 days; 8	Sahli's Hemoglobinometer	Mild increase in haemoglobin readings.

	tests in a group of female volunteers		g of dried beetroot was given to each in the morning.		
7	Effectiveness of beet root extract on level of hemoglobin and information, education and communication (IEC) on knowledge and practice on prevention of amenia among students in Mahalashmi College, Thiruvallur district	Vanitha. S, P. Pandiammal	Beetroot extract was given to the experimental group continuously for 21 days.	Sahli's Hemoglobinometer	High significant improvement in the haemoglobin level of adolescent girls at p=0.001.
8	Effectiveness of Beetroot juice on level of Anaemia among Adolescent girls	Radha C, Sumithra S.	Beetroot juice with jaggery was administered for a period of 20 days.	Taliques blot paper	Significant increase in the level of Hb among the adolescent girls after the administration of beetroot juice ($p<0.05$).
9	Quasi Experimental Study to Assess the Effectiveness of Beetroot Juice on Serum Iron, CBC & Clinical Features among Adolescent Girls with IDA in Selected Areas of Dadra and Nagar Haveli	P. Sharma, H. Patel, A.A. Mulla, S. Malik	Administration of beetroot juice to experimental group of 30 adolescent girls for 14 days.	Sahli's Hemoglobinometer and CBC	Significant improvement in the serum iron and CBC level of adolescent girls with at ($p<0.001$), with the post-test mean for clinical features of experimental group was 2.47 (SD 2.53) and post-test mean for clinical features of control group was 5.87 (SD 2.08).
10	The Intake of Beta Vulgaris and Amaranthus Tricolor L. Juice on Increasing the Hemoglobin Level	Rapael Ginting, Frans Judea Samosir, Hartono, Victor Trimanjaya Hulu, David Ongko, Dewi Anjani, et al.	One group of respondents were given 180 ml of BRJ and other group was given Amaranthus juice for 14 days.	Sahli's Hemoglobinometer	The results showed that there are significant increased levels of Haemoglobin after the intake of Beta Vulgaris juice and the Amaranthus Tricolor L juice by 1.03 gr/dL and 1.34gr/dL, respectively.
11	Effectiveness of beetroot juice on the prevention and management of anaemia	Mamata Swain, Binati Behera	The experimental group after the pre-test 100 ml of beet juice was provided to them for one month along with breakfast.	Sahli's Hemoglobinometer	After the intervention of beetroot juice, there was a high critical improvement in the Hb level of adolescent girls at p=0.001.
12	Effect of Beetroot Juice on Anaemic Patients - an Analytical Study	Pushpaanjali. G, Brundha M.P, Leslie Rani. S	200 ml mixture of beetroot and sugar is given in the midday and evening (two times a day) for 3 weeks.	Sahli's Hemoglobinometer and Complete Blood Count	There was a significant raise in Hb level and slight improvement or changes seen in MCV, MCH and MCHC at $p<0.001$.
13	Comparative Study on Effects of Beetroot Juice and Dates in Iron Deficiency Anaemia Patients	Sreekala Priyadharsini.K, Brundha M.P, Leslie Rani.S	Sample A group were given 28 dates (250g). 14 dates in the midday and 14 dates in the evening. Sample B groups were given Beetroot juice of 250ml. 125 ml in the midday and 125 ml in the evening (two times a day) for 21 days.	Sahli's Hemoglobinometer and Complete Blood Count	Significant raise in Hb level and slight improvement or changes seen in MCV, MCH and MCHC in the patients who consumed Beetroot juice than the patients who consumed dates.
14	Effect of Beet Powder (Beta Vulgaris L) with	Hilma Triana, Suharyo	The intervention group was given 8-gram	Haematology Analyzer	The p-value of haemoglobin, haematocrit

	Fe Supplementation on Increasing Hemoglobin, Hematocrit, and Erythrocyte Levels in Pregnant Women with Anaemia	Hadisaputro, Masrifan Djamil	beetroot powder with Fe supplementation once a day for 14 days, while the control group was given Fe tablets once a day for 14 days.		and erythrocyte levels in beetroot powder interventions with Fe supplementation is 0.000 <0.05, meaning that there are significant differences between the average levels of haemoglobin, haematocrit and erythrocytes before and after intervention.
15	Effectiveness of Beta Vulgaris L (BIT) Juice To Increase Haemoglobin Levels In Pregnant Women Anaemia at Primary Health Care Kotaraja	Sitti Zahyrah, Siana Dondi, Ika Wijayanti	Beetroot juice intervention was given to anaemic pregnant women	Sahli's Hemoglobinometer	The results of the Paired Sample t-test, the value of p = 0.000 (p<0.05) was obtained so that the administration of BRJ is effective for increasing Hb levels of pregnant women with anemia.
16	Beetroot Juice and Red Spinach Juice to Increase Hemoglobin Levels in Anaemic Adolescent Girls	Rudolf Boyke Purba, Olga Lieke Paruntu, Irza Nanda Ranti, Vera Harikedua, Grace Langi, Jufri Sineke et al.	The experimental Group I (n = 25) received 150 ml of beetroot juice, the experimental group II (n = 25) received 150 ml of red spinach juice, and the control group (n = 25) did not receive any intervention for 2 weeks.	Sahli's Hemoglobinometer	After 2 weeks of intervention of beetroot juice to anaemic adolescent girls, there was an increase in Hb levels from 11.47 g/dl to 12.02 g/dl at p<0.05.
17	The effectiveness of giving beetroot juice on increasing Hemoglobin (Hb) levels of adolescent women in Islamic boarding school	Kartika Pibriyanti, Hurin Safira, Lulu' Luthfiya	Beetroot juice was given every day in a row for one week at a rate of 200 ml to adolescent women in Islamic boarding school.	Sahli's Hemoglobinometer	Based on the results of the paired t-test, the haemoglobin level before and after the intervention obtained p=0.001, which means that there is a significant difference between the haemoglobin level before and after the intervention of beetroot juice.
18	A study to evaluate the effectiveness of beetroot extract upon Iron Deficiency Anaemia among adolescent girls in selected school at Kanyakumari district	J. Jeba Saranya	100 ml of beetroot juice was given to each adolescent girl for 20 days in mid-morning.	Cyanmethemoglobin method	High significant improvement in the Hb level of adolescent girls with a "t"value of 17.787 at p=0.001.

III. Discussion:

One of the most prevalent dietary deficiencies that may affect people of all social and economic position is anaemia. Adolescents and children in underdeveloped nations are more likely to develop it. The effects of anaemia in teenage girls are extensive. The majority of the causes of mortality and morbidity in this age range are avoidable. IDA, Thalassemia, Aplastic Anaemia, Haemolytic Anaemia, Sickle Cell Anaemia, and Pernicious Anaemia are some of the anaemias that are common in India. Due to chronic blood loss brought on by heavy menstruation and increasing demands for iron to support adolescent girls' fast development, IDA is a significant problem among them. The current review intensively assessed anaemia as well analysed the effectiveness of BRJ as a nutritional supplement in increasing Hb content of blood and on other blood parameters.

The above studies concluded that BRJ supplementation had mild to significant improvement in Hb levels of blood. The mechanisms by which BRJ alleviates anaemia and its symptoms are multimodal. Iron, potassium, and other minerals including calcium, salt, and magnesium are all abundant in beetroot. Vitamins A, C, folic acid, B1, B2, B6, B12, niacin, and biotin are also rich in it. Hb levels, RBC count, MCV, MCH, and MCHC have all been reported to rise when raw beetroot is consumed. One of the most effective ways to raise the Hb level is using beetroot. One explanation is that beetroot has an iron content equal to 10% of the daily need. Due to its greater iron content, BRJ has beneficial benefits on human blood and blood formation qualities. The RBCs are revived

and reactivated. Since BRJ raises Hb levels and other hematocrit indicators immediately, it can be used as an alternative to iron supplementation pills. Hb levels are raised by dietary iron supplementation in the form of BRJ. The research showed that natural, organic forms of nutrients are considerably more easily absorbed than artificial, synthetic versions. As a result, the iron in BRJ is more quickly absorbed and provides greater nutritional value than iron supplements supplied by humans. Regardless of age, beetroot is a fantastic natural remedy for persons with low blood Hb and anaemia since the iron in it is simplest to absorb into the bloodstream. By raising the RBC count and enhancing blood circulation and erythrocytes' ability to transport oxygen, it aids in the treatment of anaemia. Beetroot's higher content of vitamin C may be the cause of its improved ability to absorb iron.

Ascorbic acid concentration plays a significant part in the absorption of iron. Since ferrous iron dissolves quickly, iron absorption is more efficient and effective when it is in this state. For that we need an acidic environment in the stomach for this, and we also need a substance—ascorbic acid, or vitamin C—that can change ferric form into ferrous in the intestine. Uncooked beetroot offers a natural supply of iron and vitamin C, which has a quicker absorption rate than synthetic iron content. As a result, beetroot's natural iron concentration is simpler to absorb than manufactured iron.

In addition, beetroot contains vitamins and other trace components that are crucial for erythropoiesis. According to the results of another investigation, betacyanin may be the cause of erythropoiesis. It is rich in folic acid and vitamin B12 as well as iron, both of which are necessary building blocks for cell nuclei throughout the embryonic phases of erythropoiesis. Beetroot contains lysine, amino acids, and vitamin B6, which are all involved in the early process of haemoglobin synthesis. Additionally, globin production requires the vitamins B6 and B12. Beets are particularly potent liver and kidney cleaners, which help cleanse the circulatory system. BRJ improves blood structure and treats disorders of the large intestine, digestive system, and circulatory system. Thus, consuming fresh BRJ may aid in treating anaemia. Beets are said to create red blood cells and give blood tone, which raises the level of haemoglobin (Hb) in the blood, according to Nirman Walker, D.Sc. in "Fresh Vegetables and Fruit Juices". Beta carotene, ascorbic acid, and numerous other highly bioactive phenolics, including rutin, epicatechin, and caffeic acid, are also prevalent in beetroot and provide the vegetable antioxidant characteristics.

The BRJ is a high source of nitates and beta carotene, which helps anaemic people mobilise stored iron and raise their haemoglobin levels. Another possibility is that BRJ stimulates the rise in Hb levels by acting as sham feeding. Research indicated that, compared to the group receiving only iron pill supplementation, the Hb levels, hematocrit, and RBC count of pregnant women considerably improved when both beetroot powder and iron tablets were provided. According to comparison research on the effects of BRJ and Prickly pear (Opuntia basilaris) on anaemia, both prickly pear and beetroot contain iron and zinc, but prickly pear has a higher quantity of folic acid. Overall, it was discovered that prickly pear was more effective than BRJ at raising blood levels of haemoglobin. The comparative study on effect of BRJ and dates in management of anaemia concluded that, significant raise in Hb level and slight improvement or changes seen in MCV, MCH and MCHC in the patients who consumed BRJ than the patients who consumed Dates (*Phoenix dactylifera*). Another similar study found that Red Spinach (*Amaranthus dubius*) is more effective in increasing Hb level than BRJ in anaemic patients.

One of the main ways that phenylhydrazine causes hemolytic anaemia is by causing oxidative stress, and this was supported by the discovery that during the duration of the trial, malondialdehyde (MDA) serum levels were greater in comparison to the control group. As shown in vitro by the 2,2′-diphenyl-1-picryl-hydrazyl (DPPH-) assay, B. vulgaris extract (BVE) exhibited a potent, concentration-dependent antioxidant activity. However, concomitant administration of BVE with phenylhydrazine significantly protected against the oxidative effect on erythrocytic membranes in all tested serum samples [57]. Its high flavonoid, tannin, and gallic acid content may account for BVE's antioxidant capacity in vivo (MDA decrement) and in vitro (2,2′-diphenyl-1-picryl-hydrazyl (DPPH-) clearance) [58].

IV. Conclusion:

Beetroot appears to be one of the best ways to increase Hb levels. It is not only high in iron content but also contains folic acid, vitamin-C, potassium and fiber. Within the limitations of the study, the present review concludes that BRJ significantly improved Hb levels and is an effective treatment for anaemia, especially IDA in women of reproductive age group. Hence, BRJ can be considered as a cost effective, safe and effective treatment with no side effects. However, intense studies need to be done regarding BRJ intake and its mechanism in prevention of anaemia (e.g secondary metabolites present in *Beta vulgaris*, its safe amount of intake in patients with urolithiasis).

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