

## Evaluation of Efficacy of Medicinal Plant Supplementation Strategy Against Anemia

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### ABSTRACT

**Introduction:** Anemia is one of the most common disorders prevalent across the globe, characterized by lower hemoglobin level, causing lesser oxygen supply to cells, eventually developing an array of clinical signs. Women, due to their greater iron requirement and higher iron loss throughout the reproductive age, maximum during pregnancy and lactation, suffer mostly. Among a wide variety of causative factors, iron deficiency is the most common. Pharmaceutical interventions, in the form of iron supplements along with dietary management with iron rich foods are being adopted to address this issue. However, certain limitations of both methods are challenging to explore newer strategies. Kulekhara, a common Indian medicinal plant, having low cost, easy availability and no clinically documented side effects can be an effective option; though lack of awareness is limiting its capability to curb the issue of anemia at large scale.

**Objectives:** Evaluating the efficacy of Kulekhara, along with detailed nutritional assessment, in improving the condition of anemia and also to make people aware of its benefits.

**Methods:** Women of age group of 19-40 years (reproductive / child bearing age group) from moderate socio-economic background were chosen for the study, based on exclusion criteria. Detailed nutritional assessment, including 24-hour dietary recall, diet survey; BMI calculation; clinical / physical examination of signs and symptoms; estimation of Hemoglobin (Hb) level were performed, followed by statistical analysis. Kulekhara was introduced and re-evaluation of the clinical signs and hematological parameters were made, followed by statistical analysis.

**Result:** Despite a satisfactory range of food habits, preferences, lifestyles, nutritional support, anemia was prevalent, according to the clinical signs. Hb level was also lower than normal range. After Kulekhara supplementation, significant improvement was noticed in both parameters, namely physical and hematological examinations.

**Conclusion:** Kulekhara supplementation can be an effective boon to improve anemic conditions and eventually be effective to curb anemia at large scale.

**Keywords:** Anemia, Iron deficiency, hemoglobin, nutritional assessment, women, Kulekhara

### INTRODUCTION

Anemia is a condition characterized by a decrease in number of red blood cells (RBCs) or less than normal quantity of hemoglobin (Hb) along with decreased oxygen binding capacity of Hb (1, 2). The name 'anemia' is derived from Ancient Greek which means 'bloodlessness'. Since around 97% of total oxygen is transported via blood in oxyhemoglobin (Hb-bound) form, a fall in Hb concentration obviously reduces oxygen supply drastically and eventually develop a wide range of clinical consequences, which may be fatal in extreme cases.

Anemia is one of the most common nutritional disorders prevalent across the globe. According to WHO, a global estimation of 40% children (age group 6-59 months), 37% pregnant & 30% women (age group 15-49), comprising 1/4<sup>th</sup> of global population suffer from anemia. In India, approximately, 13.31% people suffer from anemia (around 68-70%). West Bengal having the highest prevalence rate of around 68-70% (3). Women, irrespective of age and socio-economic conditions, are usually at higher risk of developing anemia. Throughout their reproductive age, women suffer from negative iron balance, due to their greater iron requirement and higher iron loss. The process starts with the onset of menstruation and reaches at the peak among, pregnant and lactating women (3).

Anemia is a form of malnutrition, with multifactorial aspects. It is classified in diverse ways; based on the morphology of RBCs, underlying etiologic mechanisms and discernible clinical spectra etc; the 3 main classes include: excessive blood loss (hemorrhage); excessive blood cell destruction (hemolysis); deficient/defective red blood cell production (ineffective hematopoiesis); nutritional (iron, copper, proteins, vitamins) deficiencies (nutritional anemia); radiation, chemotherapy of bone marrow (aplastic anemia) etc, to name a few (4).

Most commonly, people with anemia report feelings of weakness or fatigue, general malaise, poor concentration, dyspnea (shortness of breath) on exhaustion etc. However, body tries to compensate for the lack of oxygen carrying capability of the blood by increasing cardiac output, which may lead to the development of symptoms like palpitation, angina (with pre-existing heart disease), intermittent claudication of the leg, symptoms of heart failure etc (4).

The general signs and symptoms include: pallor (pale skin, lining mucosa, conjunctiva, nail bed), with specific signs like koilonychia (in iron deficiency anemia), jaundice (in hemolytic anemia), bone deformities (in thalassemia major) or leg ulcers (in sickle-cell anemia) etc. Severe anemia, results into: hyper-dynamic circulation viz., tachycardia, bounding pulse, flow murmurs, ventricular hypertrophy (enlargement), even heart failure (4).

Among various types of anemia, nutritional anemia especially iron-deficiency anemia is the most prevalent type throughout the world. (3).

Owing to the importance of addressing this issue, various pharmaceutical management options are being used, iron supplementation being the most common option. But with indiscriminate use; without any proper check-up and guidance by expert Clinicians and Dieticians; high cost of certain medications – these pharmaceutical interventions seemed not to be as effective as desired; rather at times, it comes with certain complications like iron overdose, which in turn, render people at higher risk of bleeding. Dietary management is also a common strategy to curb anemia. However, lack of balanced diet, faulty storage and cooking methods might be a hindrance to achieve the desired result.

Along with pharmaceutical as well as dietary management strategies, medicinal supplements are also being considered to be effective in this regard. Since ancient ages, information about the therapeutic roles of various medicinal plants are mentioned in ancient Indian literatures Kulekhara (*Hygrophila spinosa*) being one of them. (5)

However, no detailed, thorough study had been done so far to establish the role of this medicinal plant as an effective tool in this regard. This study is an attempt to bridge the gap. We assessed the efficacy of Kulekhara in managing anemia among selected population.

The major objectives of the project are:

- i. Thorough, detailed assessment of food habits, food consumption, life style, socio-economic scenario of the selected population
- ii. Clinical assessment of health status by physical examination and hematological estimation
- iii. Introduction of Kulekhara supplementation and re-assessment of health status by physical examination and hematological estimation
- iv. Dose and duration –dependent comparative assessment of health status by physical examination and hematological estimation
- v. Creating awareness and knowledge about iron deficiency anemia, modification of attitude and practices of daily food intake, impact of iron rich foods and use of medicinal supplements
- v. Creating awareness and knowledge about encouraging people to use Kulekhara as an alternative, effective, inexpensive, convenient strategy along with dietary support to curb the issue of anemia in Society.

## MATERIALS & METHODS

**Selection of Area** - Bidhannagar and surrounding urban areas of Durgapur in Bardhaman (W) district was selected for the present study as it was convenient and easily accessible to the researchers to make regular visits for authentic collection of data.

**Selection of Population** - 100 women of child-bearing / reproductive age group (19-40 years) were selected for the study. The experimental protocols were explained to the selected population and the study was conducted with prior consent of the them.

i. **Nature of the Study** – Purposive

ii. **Exclusion Criteria** - Pregnant, lactating women, people with medications like iron supplementations and other medicines that promote iron loss were excluded from the study.

iii. **Duration of the Study** – 12 months

## METHODS –

After the initial procedures of area selection, sample selection, based on exclusion criteria and consent taking the following methods were adopted for the study:

1. General profile
2. Nutritional assessment including:

- i. 24-hour dietary recall
- ii. Diet survey
3. Clinical / physical examination
4. Anthropometric method
5. Hematological assessment
6. Statistical analysis

After the initial data collection, compilation and detailed analyses, Subjects were administered Kulekhara for 2 schedules – each of the schedule with a duration 90 days.

iv. *Dose* – Daily 5 - 6 leaves were taken in a cup (250ml) of water and boiled. After that, leaves were removed and only boiled water (having the extract) was taken by the Subjects. (6)

After the administration of Kulekhara for 2 schedules, while all the other parameters remained unchanged, clinical examinations and hematological assessments were carried out at every 3 month intervals to examine the effects.

1. **General Profile** - Questionnaire method was used for the general profile of the Subjects to determine the causative factor(s) of the disease. Questionnaire were prepared based on the following parameters: name, age, sex, religion, family type, number of family members, monthly income of the family, per capita income, likes and dislikes, food habits, life style, medical history of the individuals as well as family, medicine(s) taken (if any) etc.

2. **Nutritional Assessment** - A in-depth nutritional assessment / evaluation of the Subjects was carried out to get a clear picture of the existing condition. It includes the 2 following methods:

i. **24 - hour Dietary Recall** – an interview based quantitative research method was used where individuals were asked to recall foods and beverages they consumed in the 24 hours prior to the interview (7)

ii. **Diet Survey** - Diet surveys provide essential information on nutrient intake levels, sources of nutrients, food habits and attitudes. It is an essential method to yield data regarding the extent of dietary deficiencies & the quantity & types of foods required to overcome them, economic & social factors influencing food production & consumption etc. Under conditions where frank signs of malnutrition do not exist, a survey of intake of nutrients may give an indication of the adequacy of the diet for promoting optimal nutrition of individuals or groups. Diet survey was conducted following questionnaire method (8)

3. **Clinical / Physical Examination / Assessment** - signs and symptoms of anemia like weakness, shortness of breath on exercise, dizziness, headache, pallor of mucus membrane, paleness of skin & eye, intestinal problems of the subject etc. were examined in this study (9)

4. **Anthropometric Method** – Body height, weight, waist circumference, hip circumference & mid upper arm circumference etc were measured using the following instruments:

Anthropometric rod, Weighing machine, Flexible tape, Vernier callipers etc. (10)

5. **Hematological Assessment** – Estimation of hemoglobin levels in blood and complete blood count (CBC) were performed in this study in Sahli's method (11)

6. **Statistical Analysis** - The data obtained in each experiment described above were collected and subjected to statistical analysis. Results were expressed as mean  $\pm$  standard error of mean (SEM). One-way analysis of variance (ANOVA) test was first carried out to test for any differences between the mean values of all groups. If differences between groups were established, the values of the treated groups were compared with those of the control group by a comparison t-test. A value of  $p < 0.05$  was interpreted as statistically significant. (12)

## RESULTS

### 1. General Information –

- i. *Age*: Mean age of the Subjects was 30 years
- ii. *Sex*: Only Female population was selected for this study
- iii. *Religion*: 83% of the Subjects was Hindu; 13% Muslim and 4% Christian and others
- iv. *Type of Family*: 82% Subjects were from nuclear family while 18% were from joint family.
- v. *Literacy Level*: 100%
- vi. *Education*: 10% were Intermediates, 68% were Graduates and 22% were Post-Graduates.
- vii. *Family Occupation*: About 60% of families Subjects were engaged in jobs with remaining 38% were into business and 2% into other works.
- viii. *Family Income*: Monthly average Family income of the Subjects were: Rs. 50,000/- (63%), Rs. 40,000/- (28%) and Rs. 65,000/- (9%). (Table 1)

**Table 1. Basic Details of the Subjects**

Sl.	Parameters			
1	Age (Years)	19-30 (58)	31-40 (42)	Average – 30
2	Religion (%)	Hindu (83)	Muslim (13)	Christian & others (4)
3	Type of Family(%)	Nuclear (82)	Joint (18)	-
4	Education(%)	Intermediate (10)	Graduate (68)	Post-Graduate (22)
5	Family Occupation (%)	Job (60)	Business (38)	Others (2)
6	Family Income (Rs.) (%)	40,000/- (28)	50,000/- (63)	65,000/- (9)

## 2. Nutritional Assessment -

- Food Habits:** 13% of the Subjects were vegetarian and 87% were non-vegetarian.
  - Dietary Pattern:** 13% Subjects follow group A dietary pattern, 38% follow group B, 25% follow group C and the rest 25% follow group D dietary pattern.
  - Skip Meal:** Among the female Subjects 11% skip meal sometimes.
  - Observing Fast:** About 15% Subjects were found to observe fast.
- The frequency of consumption of ten (10) food groups: cereals, pulses, GLV, fruits, milk and its products, oil and fat, meat and poultry, sugar are given in Table 2.

**3. Anthropometric Measurements** - BMI calculation reported that, about 23% were grade III; 2% were grade II; 22% were grade I thinness; 43% were normal and the rest 10% were under Grade I obesity (Table 3)

**Table 2. Nutritional Assessment of the Subjects**

Sl. No	Parameters	%
1	Food Habit	
	Vegetarian	13
	Non-Vegetarian	87
2	Dietary Pattern	
	[A] Early morning + Breakfast + Mid-Morning + Lunch + Evening + Dinner	13
	[B] Breakfast + Lunch + Evening + Dinner	38
	[C] Breakfast + Mid-Morning + Lunch + Dinner	25
	[D] Breakfast + Lunch + Dinner	25
	[E] Lunch + Dinner	0
3	Skip Meal	Yes (11)
		No (89)
4	Observe Fast	Yes (15)
		No (85)

**Table 3. Summary of Nutritional Status of the Subjects based on Body Mass Index (BMI)**

Grade/BMI	%
Grade III thinness(<16.0)	23
Grade II thinness(16.0-16.99)	2
Grade I thinness(17-18.49)	22
Normal (18.5-24.9)	43
Not obese (<25)	--
Grade I (25-29.9)	10
Grade II (30-40)	--
Grade III (>40)	--

**4. Food Consumption Frequency of the Subjects** – Average nutrient consumption compared with RDA is enlisted in Table 4 and foods consumed daily, in Table 5.

Green leafy vegetables were consumed daily by 63% and weekly by 37% Subjects.

Milk & its products were consumed daily by 95% and weekly by 5% Subjects.

Meat and Fish were consumed daily by 33%, weekly by 28%, biweekly by 20%, monthly by 9%, occasionally 5% and never consumed by 5% Subjects.

Egg was consumed daily by 30%, weekly by 50% and monthly by 20% Subjects.

Fruits were consumed daily by 50% Subjects and monthly by 50% Subjects.

**Table 4. Average Nutrient Consumption compared with RDA / day**

Nutrient	Energy (Kcal)	Carbohydrate (g)	Protein (g)	Fat (g)	Iron (mg)	Vitamin C
Intake	1938 ± 7.72	347.5 ± 2.99	56.45 ± 0.82	35.92 ± 1.43	13 ± 0.5	32.23 ± 0.42
RDA	1900	308.75	55	42.22	21	40
Difference	+38	+38.75	+1.45	+17.16	-8	-8.77

**Table 5. Summary of Food Consumption Frequency of the Subjects**

Sl. No.	Food items	Consumption (%) of the Subjects					
		Daily	Weekly	Biweekly	Monthly	Occasionally	Never
3	Fish / Meat	33	28	20	9	5	5
4	Egg	30	50	-	20	-	-
5	Dairy products	95	5	-	-	-	-
6	Green vegetables	63	37	-	-	-	-
8	Fruits	50	50	-	-	-	-

**5. Habit of Exercise** - about 35% of Subjects have the habit of exercise, among which only 10% go for daily while 25% go for weekly. (Table 6)

**Table 6. Habit of Exercise**

Parameter	Yes (35%)		No (65%)	
Habit of Exercise	Daily	Weekly	Daily	Weekly
	10%	25%	63	63

## 6. Physical Examination of the Subjects –

- Before Kulekhara supplementation*, the Subjects reported the following clinical status: Giddiness - 88%; Breathlessness - 75%; Anorexia - 70%; Fatigue - 63%; Decreased physical activity - 50%; Lack of interest - 35%; Irritability - 30%; Dimness of vision & headache - 25%; Skin dryness - 20%; Constipation, palpitation & acidity - 52%, Diarrhea - 7%; Hair fall – 60%
- After taking Kulekhara supplementation (1<sup>st</sup> Schedule)*, the same Subjects showed - Giddiness - 50%; Breathlessness - 38%; Anorexia - 30%; Fatigue - 25%; Decreased physical activity - 18%; Lack of interest - 10%; Irritability - 20%; Dimness of vision & headache - 13%; Skin dryness - 10%; Constipation, palpitation & acidity - 10%; Diarrhea - 5%; Hair fall – 50%
- After taking Kulekhara supplementation (2<sup>nd</sup> Schedule)*, the same Subjects showed - Giddiness - 15%; Breathlessness - 15%; Anorexia - 10%; Fatigue - 20%; Decreased physical activity - 15%; Lack of interest - 5%; Irritability - 10%; Dimness of vision & headache - 10%; Skin dryness - 5%; Constipation, palpitation & acidity - 5%; Diarrhea - 0%; Hair fall – 45% All data are enlisted in Table 7.

All parameters, except skin dryness and hair fall, examined, showed significant improvement (increase / decrease) after Kulekhara supplementation, when compared to without / before Kulekhara supplementation.

**Table 7. Physical Examination of the Subjects Before & After Kulekhara administration**

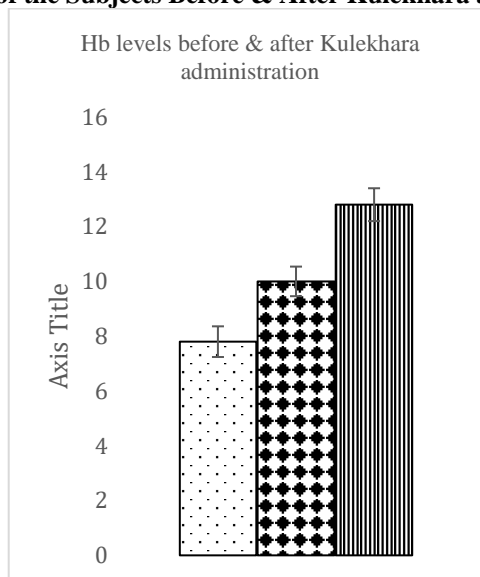
Parameters	Before (%)	After		Changes Observed
		1 <sup>st</sup> Schedule (%)	2 <sup>nd</sup> Schedule (%)	
Giddiness	88	50	15	Improvement
Breathlessness	75	38	15	Improvement
Fatigue	63	25	20	Improvement
Dimness of vision & headache	25	13	10	Improvement
Anorexia	70	30	10	Improvement
Constipation, palpitation & acidity	52	10	5	Improvement
Decrease physical activity	50	18	15	Improvement
Hair Loss	75	28	70	Improvement
Skin dryness	20	13	10	Improvement*
Irritability	30	20	10	Improvement
Lack of interest	35	10	5	Improvement
Diarrhea	15	5	0	Improvement
Hair fall	60	50	45	Improvement*

[All the changes (except \*) were statistically significant]

**7. Hematological Assessment** –Hemoglobin level estimation of the Subjects, before and after (1<sup>st</sup> and 2<sup>nd</sup> Doses) Kulekhara Supplementations reported significant, dose and duration - dependent increase.

Parameters	Before Supplementation	After Supplementation	
		1 <sup>st</sup> Schedule	2 <sup>nd</sup> Schedule
Value	7.8	10	12.8
%		31.4	65.39

**Fig 1. Hb% of the Subjects Before & After Kulekhara administration**



[The figures within the parentheses indicate the no. of observations and the above data are the means of those observations  $\pm$  SEM. One-way analysis of variance (ANOVA) test followed by a multiple comparison t-test was performed. Mean values are significantly different by ANOVA at  $p < 0.05$ . One-way analysis of variance (ANOVA) test followed by a multiple comparison t-test was performed. Mean values are significantly different by ANOVA at  $p < 0.05$ .]

## DISCUSSION

The present, purposive study was conducted in Bidhannagar and surrounding urban areas of Durgapur in Bardhaman (W) on a sample size of 100 women of child-bearing / reproductive age group (19-40 years) over a period of 12 months. Pregnant, lactating women, people with medications like iron supplementations and other medicines that promote iron loss were excluded from the study. The experimental protocols were explained to the selected population and the study was conducted with prior consent of the them. After the initial procedures of area selection, sample selection, based on exclusion criteria and consent taking the following methods were adopted for the study: General profile; Nutritional assessment including: i. 24-hour dietary recall and ii. Diet survey; Clinical / physical examination of signs and symptoms; Anthropometric method and BMI calculation; Hematological assessment (Hemoglobin levels in blood) were performed, followed by Statistical analysis.

After the initial data collection, compilation and detailed analyses, Subjects were administered the specified dose of Kulekhara for 2 schedules – each of the schedule with a duration 90 days.

After the administration of Kulekhara for 2 schedules, while all the other parameters remained unchanged, clinical examinations and hematological assessments were carried out at every 3 month intervals to examine the effects.

The general profile study of the Subjects revealed that most of the Subjects were from nuclear family and has good socio-economic background in terms of literacy (100%), educational qualification, monthly family income etc.

Nutritional status of the Subjects were studied based on body mass index (BMI) which showed that, the Subjects were mostly having normal BMI with none of them were obese.

Nutritional assessment study based on food habits revealed that, they were mainly non-vegetarian (87%) with few vegetarian (13%). Majority of them were found to follow a four (4) meal per day dietary pattern.

Analysis of the food consumption pattern like fruits, dairy products, egg, meat, fish, green vegetables etc revealed that, the Subjects follow a typical normal dietary pattern; most of them consume green leafy vegetables on a daily basis with

relatively fewer on weekly basis; same was followed in case of consumption of dairy products; meat, fishes and eggs are consumed in a varied way; fruit consumption also showed daily and monthly variations.

The Subjects were found to have sedentary lifestyle with only about 10% having the habit of daily exercise, while 25% go for weekly basis.

Upon analyses of clinical / physical examinations, it was found that, most of the subjects reportedly had the prominent of the signs and symptoms associated with anemia, including: giddiness, breathlessness, anorexia, fatigue, decreased physical activity, lack of interest, irritability, dimness of vision & headache, skin dryness, constipation, palpitation & acidity, diarrhea, hair fall etc. After the 2 schedules of Kulekhara supplementations, it was found that, there were visible, prominent, significant, dose and duration – dependent improvements in all those parameters, except skin dryness and hair fall (insignificant improvement).

Hematological evaluation, the most important marker of anemia, revealed that, most of the subjects were having Hemoglobin levels lower than the normal values. With the completion of the 2 doses of Kulekhara supplementations, significant, dose and duration - dependent increase were noticed in the Hb levels of the same subjects.

Detailed data analyses revealed that, most of the Subjects belonged to good socio-economic background; having good education levels; food choices and preferences; food availability; RDA consumption, lifestyles - all of which correlated with good, satisfactory nutritional status. This was evident from their BMI results, with mostly showing no major state of malnutrition.

Despite a moderately fair nutritional and lifestyle status, most of the Subject complained / reported about the clinical signs and symptoms associated with anemia. These symptoms can be correlated with the lower oxygen supply to all the cells, tissues and organ systems of the body. A fall in hemoglobin (the respiratory pigment) – the transported protein for oxygen directly reflects in lower oxygen supply to the whole body. Lack of oxygen in cells eventually leads to energy deficiency, which can be correlated with the signs like giddiness, fatigue, decreased physical activity, lack of interest, irritability, dimness of vision & headache. (13) Also cognitive impairment, anorexia, behavioural changes, mood swings etc develop with prolonged oxygen deficiency to nervous system. (14) In order to compensate the lack of oxygen, cardio-respiratory activities increase collaboratively, to ensure smooth and better oxygen supply. Increased breathing rate and lack of oxygen eventually develops breathlessness. Increased heart rate (tachycardia) results into palpation.

After the introduction of Kulekhara supplementation (1<sup>st</sup> and 2nd doses), it was found that there was significant, dose and duration - dependent increase (31.4% and 65.39%, respectively). An improvement in hemoglobin readily increases oxyhemoglobin formation (binding of oxygen with hemoglobin) and eventually ensures greater oxygen supply to all the cells and tissue and organ systems of the whole body. This obviously reduces the complications development owing to oxygen deficiency. These can be correlated with lesser no. of Subject reporting the clinical signs and symptoms of anemia, after the dose and duration - dependent Kulekhara supplementations and significant improvement in their health conditions.

However, detailed study is required to assess the effect of Kulekhara on CBC (complete blood count, hematocrit values, TIBC (Total iron binding capacity), UIBC (Unsaturated iron binding capacity), serum ferritin and transferrin levels to for better knowledge. Further studies are required in this regards.

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