INTERNATIONAL RESEARCH JOURNAL OF PHARMACY
www.irjponline.com ISSN 2230 – 8407
Research Article

A ROLE OF STARCH OF *ELEUSIN CORACANA* GAERTN. (RAGI SATWA) IN MANAGEMENT OF MALNUTRITION

Patil Y. R.[1]*, Sawant R. S.[2]
[1]Associate Professor & Head of Department, Dept. of Swasthavritta, Govt. Ayurved College, Nanded, M.S., India
[2]Assistant Professor, Dept. of Rasashastra & B. K, Govt. Ayurved College, Nanded, M.S., India

Article Received on: 17/12/11 Revised on: 11/01/12 Approved for publication: 30/01/12

*Email: dr.yeshraj@gmail.com

ABSTRACT
Malnutrition is the most wide spread condition affecting mainly health of children. It is defined as and appose; a pathological state resulting from a relative or absolute deficiency of one or more essential nutrients. Ragi is the common name of Finger Millet in Southern part of India. It is one of the most nutritious food and one of the easy one to digest. It is rich in calcium and protein and also has good amount of iron and other minerals. It is low in fat most of which are unsaturated fats. An open-label, prospective, interventional, and exploratory clinical trial was carried out to evaluate the efficacy of Ragi Satwa 3o patients suffering from mild to moderate malnutrition. Administration of "Ragi Satwa" for 90 days showed a significant increase in mean score of BMI, Agni, height for age, weight for height, mid arm circumference, weight for age & abdominal girth. It also enhanced biochemical parameters like Hb, RBCs, TLC, ESR, Sr. protein, Sr. albumin.
KEY WORDS: Ragi, *Eleusin coracana Gaertn*., Malnutrition, Starch, Satwa

INTRODUCTION

Malnutrition is a major health problem, especially in developing countries. Water supply, sanitation and hygiene, give their direct impact on infectious disease, especially diarrhoea, are important for preventing malnutrition. Both malnutrition and inadequate water supply and sanitation are linked to poverty. The impact of repeated or persistent diarrhoea on nutrition-related poverty and the effect of malnutrition on susceptibility to infectious diarrhoea are reinforcing elements of the same vicious circle, especially amongst children in developing countries.

Malnutrition essentially means "bad nourishment". It concerns not enough as well as too much food, the wrong types of food, and the body's response to a wide range of infections that result in malabsorption of nutrients or the inability to use nutrients properly to maintain health. Clinically, malnutrition is characterized by inadequate or excess intake of protein, energy, and micronutrients such as vitamins, and the frequent infections and disorders that result. Malnutrition in all its forms increases the risk of disease and early death. Protein-energy malnutrition, for example, plays a major role in half of all under-five deaths each year in developing countries (WHO 2000) (Table 1& 2). Severe forms of malnutrition include marasmus (chronic wasting of fat, muscle and other tissues); cretinism and irreversible brain damage due to iodine deficiency; and blindness and increased risk of infection and death from vitamin A deficiency.[1]

Ragi, known as millet, Nachni, Sollu, or Sattemavu is rich in calcium, iron, protein and some rare nutrients such as methionine. Also digests easily from infancy through old age, and its nutrients are highly absorbed. It costs less than wheat, rice, or dairy milk, while delivering superior nutrition.[2]

Ragi is an ideal first food after an infant reaches at least 6 months of age. Sprouting ragi increases the bioavailability of its iron to 88%, comparable only to mother's milk (and 8 times higher than cow's milk) (Table 3).[3]

Major portion of Ragi is carbohydrate, around 80%. The Fat percentage is quite less which is good. Protein and fiber content is not great but it is relatively less in their share. 100 grams of Ragi has roughly on an average of 336 KCal of energy in them.

Ragi also has some good number of Essential Amino Acids (EAA) which are essential for human body. Few of the key EAAs which Ragi has are Valine, Methionine, Isoleucine, Threonine and Tryptophan. Below section briefly explains why these are essential for us.

Valine is essential for repair of tissues, muscle coordination and metabolism and also helps maintain balance of nitrogen in the body. It also help promote mental calmness and enhance maintain mental vigor.

Isoleucine is essential for ensuring blood formation, keeping a check on blood sugar levels. It also helps heal and repair muscle tissues, bones and skin.

Threonine helps maintain protein levels in the body. It also helps formation of tooth enamel, also prevents formation of fat in the liver.

Tryptophan which act as natural relaxant and help fight anxiety, depression and insomnia. They also help in treating migraine headaches. They reduce excess appetite and help control weight gain; they also release of growth hormones.

Methionine which is sulfur based amino acid which is essential for various activities in human body. It is said to help promote growth of healthy skin and hair. The Sulfur which we get from Methionine helps produce a substance called lecithin which helps reduce cholesterol, reduce fat inside the livers and help protect kidneys. This Methionine is generally lacking in staple diet of some of the vegetarians and hence regular Ragi intake will help get enough of these amino acids.[4]

Ragi Vs Other Grains (Wheat, Maize, Brown Rice)

Below table shows how Ragi (finger millet) stands against other staple grains – Wheat, Maize and Brown Rice (Table 4).

Table 1: Classification suggested by FAO/WHO expert committee

Nutritional Status	Body weight As% + Std. for age	Edema	Deficit in wt. for Ht.
Underweight	80-60	0	Minimal
Nutritional Dwarfism	Less than 60	0	Minimal
Marasmus	Less than 60	0	++
Kwashiorkor	80-60	+	++
Marasmic-kwashiorkor	Less than 60	+	++

Table 2: Classification of nutritional status suggested by IAP (Indian academy of Pediatrics)

Nutritional grade	Percentage of standard weight for age
Normal	More than 80%
Grade I	71-80%
Grade II	61-70 %
Grade III	51-60%
Grade IV	<50%

Table 3: Ragi Nutrition Facts (Chart)

Content	Amount (Typical)	Content	Amount (Typical)
Carbohydrate	72.6	**Valine**	413 mg/dl
Protein	7.7	**Phenylalanine**	325 mg/dl
Fiber	3.6	**Isoleucine**	275 mg/dl
Fat	1.3	**Threonine**	263 mg/dl
Calcium	350 mg	**Methionine**	194 mg/dl
Iron	3.9 mg	**Tryptophan**	191 mg/dl
Niacin	1.1 mg	**Lysine**	181 mg/dl
Thiamin	0.42 mg	**Cystine**	163 mg/dl
Riboflavin	0.19 mg	**Valine**	413 mg/dl
Leucine	594 mg/dl	**Phenylalanine**	325 mg/dl

Table 4: Ragi Nutrition Chart (Comparison)

Content (grams)	Brown Rice	Wheat	Maize	Ragi
Energy (K Cal)	362	348	358	336
Carbohydrate	7.9	11.6	9.2	7.7
Protein	7.9	11.6	9.2	7.7
Fiber	1.0	2.0	2.8	3.6
Fat	2.7	2.0	4.6	1.5

We can make out from the chart that Protein content in Ragi is not on the higher side. It is least on Calories, Protein and Fat. It is relatively high on Protein. Ragi has very high amount of calcium which are way more than others. The Ragi also has traces of Iron. Other minerals are not present in high numbers.[5]

Objective

The primary objective of the study was to evaluate the efficacy of starch of Ragi in malnutrition of children of age group between 5 to 10 yrs.

MATERIALS & METHOD

The study was an open-label, non-comparative, interventional, and exploratory clinical trial.

Plant Material

Dried grains of Eleusin coracana Gaertn. were collected from local market of Nanded, Maharashtra. This raw material was authenticated in the Pharmacognosy Laboratory.

Preparation of Ragi Starch

The starch was prepared in Dept. of Rasashastra & Bhaishajya Kalpana, Govt. Ayurved College, Nanded.

Procedure

Ragi grains were soaked in Luke warm water for half an hour. After half an hour grains were taken out and mildly crushed. After that these grains were again soaked in Luke warm water for four hours. Then these grains were rubbed with hands till their stratum was removed. The remaining matter kept for precipitating for an hour. Then starch precipitated at bottom of vessel was collected & allowed to dry in cool place.

Dose: 10 gm twice per day.

Anupana: Warm Milk – 100 ml

Sample Size Calculation

Sample size calculation was based on the assumption that a sample size of 30 cases would provide a 90% power to detect mean change in frequency of growth per fortnight at 5% level of significance.

Institutional Ethics Committee Approval and Regulatory Compliance

Before the initiation of the study, the study protocol and related documents were reviewed and approved by Institutional Ethics Committee at Govt. Ayurved College & Govt. Ayurved hospital, Nanded, Maharashtra. The study was conducted in accordance with Schedule Y of Drugs and Cosmetics act, India, amended in 2005 and ICMR ethical guidelines for biomedical research on human participants 2006.

Patients screening and recruitment

Children (age group, 5 to 10 years) attending the Outpatient Clinic at Govt. Ayurved College & Govt. Ayurved hospital, Nanded, Maharashtra and meeting all the inclusion criteria were recruited in the trial. Precautions were taken not to recruit children from possible vulnerable groups.

Inclusion Criteria

1. Children of both sexes having age between 5 to 10 years
2. I & II grade malnourished children
3. Classical patients of malnutrition as per anthropometric measurements mainly weight and height
4. Immunized children

Exclusion Criteria

1. Severe form of malnutrition disorders Eg. Kwashiorkor & Marasmus
2. Patients having age below 5 years and above 10 years
3. HIV, HbsAg positive patients
4. Unimmunized children

Study Procedure

At the screening visit, following written informed consent, children were considered for study. Children were assessed and evaluated on the basis of objective and subjective parameters at interval of 30 days for 3 months.

1. **Objective parameters:** BMI, mid arm circumference, head circumference, abdominal girth, weight, height, chest circumference,
2. **Investigations:** CBC, ESR, Serum protein, Serum albumin

Gradation of Subjective Parameters

1. BMI

Range	Score
>20	0
18-19	1
15-17	2
<15	3

2. Height for age

Range	Score
>90% of expected	0
85-89% of expected	1
80-84% of expected	2
<80% of expected	3

3. Weight for height

Range	Score
>90% of expected	0
90-81% of expected	1
80-71% of expected	2
<70% of expected	3

4. Mid arm circumference/ Head circumference

Range	Score
0.32-0.33	0
0.31-0.28	1
0.27-0.25	2
<0.25	3

5. Weight for age

Range	Score
>90% of expected	0
90-75% of expected	1
74-60% of expected	2
<60% of expected	3

6. Abdominal girth

Range	Score
>90% of expected	0
90-81% of expected	1
80-71% of expected	2
<70% of expected	3

7. Malnutrition

0 – Normal – No Malnutrition
1 – Mild under nutrition – Ist grade malnutrition
2 – Moderate under nutrition – IInd grade malnutrition
3 – Severe under nutrition – IIIrd grade malnutrition

Statistical Analysis

Statistical analysis of the study data was performed by an independent statistician using statistical software SPSS 10.0. Data describing quantitative measures were expressed as median or mean ± SD or SE or the mean with range. All *P* values are reported based on two-sided significance test and all the statistical tests were interpreted at 5% level of significance.

RESULT

Of 30 children included in the trial, 12 were male while 18 were female. Thirty patients completed the study. No patient was dropped out or withdrawn due to the adverse event or an adverse reaction. Study treatment did not cause any significant change in vital signs like pulse rate, body temperature, respiratory rate, and the blood pressure.

Changes observed after 90 days administration of Ragi starch revealed following observations [Table 5 & 6]

- Statistically decrease in score of BMI, Agni, height for age, weight for height, mid arm circumference, weight for age & abdominal girth shows improvement in all the symptoms of malnutrition.
- Statistically significant increase in Hb, RBCs, TLC, ESR, Sr. protein, Sr. albumin at end of study.

Table 5: Effect of Ragi Satwa on various symptoms after 90 days of administration

Symptom	Before Treatment Mean ± SD	After Treatment Mean ± SD	'z'	*'P'*
BMI	1.533 ± 0.5074	0.733 ± 0.4497	4.19	<0.001
Agni	1.4 ± 0.4982	0.566 ± 0.504	4.37	<0.001
Height for age	1.533 ± 0.5074	0.833 ± 0.379	3.74	<0.001
Weight for height	1.533 ± 0.5074	0.633 ± 0.4901	4.45	<0.001
mid arm circumference	1.4 ± 0.4982	0.633 ± 0.4901	4.19	<0.001
weight for age	1.6 ± 0.4982	0.533 ± 0.5074	4.54	<0.001
Abdominal girth	1.5 ± 0.5085	0.7 ± 0.5959	4.28	<0.001

Table 6: Effect of Ragi satwa on various biochemical parameters after 90 days of administration.

Biochemical Parameter	Before Treatment Mean ± SD	After Treatment Mean ± SD	z'	*P*'
Hb	10.6 ± 0.6653	11.2 ± 0.6367	6.963	<0.001
RBCs	3.84 ± 0.45	4.25 ± 0.4987	6.861	<0.001
WBCs	5.58 ± 0.759	6.05 ± 0.8131	5.593	<0.001
ESR	14.57 ± 4.1496	13.7 ± 3.724	4.176	<0.001
Sr. Protein	6.03 ± 0.4555	6.58 ± 0.575	7.116	<0.001
Sr. Albumin	3.15 ± 0.3636	3.52 ± 0.3912	6.256	<0.001

DISCUSSION

This study confirms the beneficial effect of starch of *Ragi* in Malnutrition. The mean weight & height gain significantly increased (P<0.001). The increase in mean head circumference at end of study (i.e., on day 120) was also statistically significant, but the mean score was lower than that of baseline value and was clinically significant (P<0.001). There was statistically significant improvement in mean score of Agni i.e. food intake was increased after 12 weeks of treatment.

The changes in biochemical parameters like Hb, RBCs, TLC, ESR, Sr. protein, Sr. albumin after 90 days were found to be statistically significant. It indicates that in long term administration, the ragi satwa has significant effect on parameters mentioned above.

The present investigation was an open-label, uncontrolled, and pilot study and was performed to gather the preliminary reports on efficacy of Ragi in malnutrition. A randomized, double blind, comparative clinical study with placebo or other conventional formulations in larger population may endorse the findings of the current study.

CONCLUSION

An Ayurvedic medicine starch of Ragi is significantly effective on growth of children. Twelve weeks of treatment with the drug also show improvement in height, weight & hematological values.

These findings suggest that Ragi starch is an effective, safe, and herbal formulation for the children growth. Further comparative, double blind studies with large sample size would be able to confirm the above findings.

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Source of support: Nil, Conflict of interest: None Declared