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(REVIEW ARTICLE)

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# Prevalence and public health significance of anemia among non-pregnant, non-lactating tribal women of reproductive age (15-49 years) in India

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## Abstract

**Background:** In reproductive age, anemia is high burden and significant loss of maternal life in India. In general anemia largely a nutritional deficiency disorder, suffering about 50% of all women during reproduction.

**Objectives:** This review works elucidates the prevalence rate and highlighting the inadequacy or opportunities to refocus this area which are taken but lag behind these or could find other solutions.

**Methods:** The methodology of this review work are simply searching of published literature review, articles, periodicals, through online database, journal etc. The article selected from the year 2000 to 2020 for those work studied key areas of tribal non-pregnant, non-lactating reproductive women between 15-49 years age. This review study included final 20 eligible research papers those conducted on same age and physiological condition of tribal women.

**Results:** Out of 20 selected paper 7951 sample were gather and tabulated for analysis. The range of lowest 48 samples to 3923 big sample was varied. In general anemia prevalence calculated by 65.3% (95% CI: 64.3 – 66.4) in studied subjects.

**Conclusion:** Anemia is a worst situation among tribal women in India as per WHO classification of severity of anemia, indicating need based urgent steps.

**Keywords:** Anemia; Women; Micronutrient Deficiency; Iron deficiency; Tribal India

## 1. Introduction

The manifestation of a disease is much more of a worrying issue as the signs indicate underlying disturbed ease or literally what we call 'disease'. The appearance of ailment happens when indications developed so strong that the patient doings upon their indications [1]. Anemia is one such disease that is resulted for lower hemoglobin or hematocrit value. Red blood cells (RBC) containing a protein component, hemoglobin which transports oxygen to the whole body [2]. Lowering of Hb results the body may not get enough oxygen that they need to work the way they should. Clinically it can manifest as weakness or tiredness, unhappiness, and reduced mental function [3]. Anemia is a condition of reduced total

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oxygen-carrying hemoglobin and/or red blood cells in blood [4][5]. According to WHO, below two standard deviations (SD) of Hb concentration or less from the population mean initiate anemia, which also vary with gender, age and populations [6].

Now a days, many developed countries like USA, fighting against different blood borne diseases like anemia. These countries will affect their population about 6% in many age groups from women to people who are risk for chronic health disorders [2]. WHO study group recommended hemoglobin level to diagnose anemia based on hemoglobin concentration in three stages- mild (110g/l to 119g/l), moderate (80 to 109g/l), and severe (< 80 g/l) among pre and post reproductive age of both sex, which are represented in (table 1) [7]. Women are more susceptible to anemia due to blood loss through menstruation and increase quantity of blood stock at pregnancy [2]. In the Global Nutrition Targets framework 2025, anemia is being key target, by achieving a 50% lessening of its occurrence in females with reproductive age endorsed by the World Health Assembly 2012 [8]. A systemic review study done in 2011 suggested that globally about 496 million (409–595 million) women are affected by anemia, which are non-pregnant and the worst affected regions were South Asia, West and Central Africa [9]. In the South-East Asia region, this number is approximately 190.6 million [9]. Demographic and Health Survey (DHS) report (2005-06) shows anemia (<12g/dl) prevalence in women and children in India is high among other South East Asian countries [10].

The most common type of anemia is iron-deficiency anemia across all ages [11]. Globally over 1.6 billion people affected by iron deficiency anemia most cases are from South Asia, Central and West Africa [9][10]. The most vulnerable people are indigenous groups of people around world. They represent approximately 476 million worldwide over more than 90 countries and make 6% of global population [12]. A significant maternal death is due to anemia and most cases due to low concentration of hemoglobin worldwide [9]. A systematic review data shows higher burden of anemia among indigenous people compare to general population [13]. Prevalence of nutritional anemia is largely distributed and affecting one quarter of world population [14]. In India, in view of anemia prevalence rate, there is large inequality of case distribution between inter-state and Union Territories. As per NFHS-2015-16 report, the percentages of about 80%, 76% and 66% women anemia cases respectively from Dadra and Nagar Haveli, Chandigarh, Andaman and Nicobar Island [15] and more than 60% anemia cases from Jharkhand, Haryana, West Bengal, Bihar and Andhra Pradesh [16]. The anemia prevalence of high-altitude states are Mizoram (25%), Manipur (26%), and Nagaland (28%). India is a large populous country and a committed nation to achieve Sustainable Development Goals (SDG) to reduce anemia prevalence at a set target level. Therefore, country needs more focus on women's anemia concern, precisely strata or sub-population level, where tribal women's reproductive age (15-49 years) is one among high priority groups [16].

As per census data 2011, India holds the estimated 10.4 crores tribal population which is roughly 8.6% of total population. They are inhabited mainly in forest and hilly regions of the country. Indian constitution has classified 705 Scheduled tribes and marked 75 as Particularly Vulnerable Tribal Groups (PVTGs), and that groups reside in 18 States and one Union Territory (UT) of India. The Scheduled Tribe male and female population is 52547215 and 51998501 respectively [16]. There is a need for more attention over both sexes' health concerns, especially for particularly vulnerable tribal groups.

India is a heavily populated country after china, although the per capita health expenditure cannot affordable. There is a health gap among different strata of the population; anemia is one priority health disorder. Approximately 50% of India's population is affected by anemia and women are more affected than men. In India, 20– 40 % maternal death is due to anemia [17]. Tribal women (15-49) are more ubiquitous in anemia cases, as NFHS-4 data shows prevalence rate is 59.9% [18]. There is a lack of broader coverage about anemia monitoring among Indigenous people worldwide. India has faced the same challenges [13]. Moreover, females are greater risk of developing anemia across different age groups and geographic regions worldwide [19]. In India, anemia is persistent, and the prevalence, not well drops, which are 53% of women (15-49years), is affected as per NFHS-4 survey report [18]. An article indicates anemia prevalence in women falls with an increased mean year of schooling and household income [14]. There is lack of sufficient published review literature among tribal communities in respect to proportion of population and number of vulnerable groups [20]. Since there is no wide scale coverage of published literature on anemia burden in tribal non-pregnant, non-lactating women age group 15- 49 years in India. Therefore, this contemporary review work is being studied for evaluation of the magnitude of the anemia burden and the community health consequence of tribal non-Pregnant non-lactating women (NPNL) throughout India.

## 2. Methodology

This review work focused on the overall anemia prevalence rate particularly tribal reproductive age (15 – 49years) women (non-Pregnant non- lactating women) in India. This review's methodology identifies relevant work on published papers on this subject in India's various states. The data on published works of literature is searched by electronic

platforms like Google, Google scholar, Pub Med, Researchgate, Springer from 2000 to 2020. Initially, the search items were nonspecific and huge on anemia but subsequently screen according to study goals. The keywords used to search relevant published articles include occurrence, determinants and distribution of anemia and its prevalence, tribal, micronutrients, WHO and UNICEF, India NFHS, state-wise tribal, particularly vulnerable tribal groups (PVTGs).

**Table 1** WHO recommendation on Hemoglobin cut-off for anemia at sea level (g/dl)

| Population | Non-anaemia | Mild | Moderate | Severe |
|---|---|---|---|---|
| 6 - 59 months Children | ≥11.0 | 10.0-10.9 | 7.0-9.9 | < 7.0 |
| 5 - 11 years Children | ≥11.5 | 11.0-11.4 | 8-10.9 | < 8.0 |
| 12 - 14 years Children | ≥12.0 | 11.0-11.9 | 8-10.9 | < 8.0 |
| 15 years & above non-pregnant women | ≥12.0 | 11.0-11.9 | 8-10.9 | < 7. |
| Pregnant women | ≥11.0 | 10.0-10.9 | 7-9.9 | < 7.0 |
| 15 years & above Men | | 11.0-12.9 | 8-10.9 | < 8.0 |

Sources: WHO VMNIS, 2011[21]

**Table 2** WHO Classification of Public Health Significance of anemia

| Category of public health significance | Prevalence of Anemia (%) |
|---|---|
| Severe | ≥40.0 |
| Moderate | 20.0-39.9 |
| Mild | 5.0-19.9 |
| Normal | ≤4.9 |

Sources: WHO VMNIS, 2011[21]

**Table 3** Age-sex specific RDA of Iron, Folic acid& Ascorbic acid (ICMR, 2020) [22]

| Individuals | Age group | Body weight(kg) | Iron (mg/day) | Folate (µ/day) | Vit-C (mg/day) |
|---|---|---|---|---|---|
| Man | | 65 | 19 | 300 | 80 |
| Women | NPNL | 55 | 29 | 220 | 65 |
| | Pregnant | 55+10 | 40 | 570 | 80 |
| | Lactation (0-6m, 7-12m) | - | 23 | 330 | 115 |
| | | - | | 330 | |
| Infants | 0-6 m | 5.8 | - | 25 | 20 |
| | 7-12m | 8.5 | 3 | 85 | 27 |
| Children | 1-3yrs | 11.7 | 8 | 110 | 27 |
| | 4-6yrs | 18.3 | 11 | 135 | 32 |
| | 7-9yrs | 25.3 | 15 | 170 | 43 |
| Boys | 10-12yrs | 34.9 | 16 | 220 | 54 |
| Girls | 10-12yrs | 36.4 | 28 | 225 | 52 |
| Boys | 13-15yrs | 50.5 | 22 | 285 | 72 |
| Girls | 13-15yrs | 49.6 | 30 | 245 | 66 |
| Boys | 16-18yrs | 64.4 | 26 | 340 | 82 |
| Girls | 16-18yrs | 55.7 | 32 | 270 | 68 |

Most of study article had been calculated based on WHO reference cut-off level of hemoglobin for drawing inferences about prevalence rate and degree of severity. However, some review articles were used NFHS reference cut-off point. To the knowledge of anaemia diagnosis, the WHO recommended Hb cut-off value at various age groups and grade of anemia i.e., mild, moderate or severe cases will be represented at Table 1&2[21]. Age and sex specific RDA of iron, folic acid and Vitamin-C are presented in table 3 [22].

## 3. Results

The total sample size of 20 selected articles sums into 7951 cases and the size of magnitude vary from minimum 48 to highest 3923cases (table 4) [23-42]. And within total sample the average percentage of prevalence is 65% at 95% confidence interval ranged lowest 64.3% to upper 66.4% anemic cases. The minimum range of anemia was 44.9% as reported by De et al, 2006 [24] from west Bengal (table 4). In contrary, highest rate of anemia (100%) was found among Munda women of west Bengal [23]. According to WHO reference criteria of anemia for public health significance, tribal women in India, are being severe affected with very high prevalence, indicating worst situation. Therefore, there is urgent need a nutrition education programme to improve their hemoglobin status.

**Table 4** Summary of data collected from various studies on anemia

| | Studied states | Ethnic groups | Year of data collection | Age groups (Years) | Sample Hb cut off | Methods of Hb. Estimation | Sample | Prevalence of anemia (%) |
|---|---|---|---|---|---|---|---|---|
| Ghosh&Bharati, 2003[23] | West Bengal | ST | 2000 | 15-42 | <12g/dl (WHO) | Sali's method | 105 | 100 |
| De et al., 2006[24] | West Bengal | ST | - | 15 - 49 | 11g/dl (WHO) | Cell count | 463 | 44.9 |
| Unisa et al.,2010[25] | West Bengal | ST | 2010 | 15 - 49 | <12g/dl (NFHS-2) | Cyano-haemoglobin | 137 | 66.0 |
| De et al., 2011[26] | Assam | ST | - | 15 - 45 | 11g/dl (WHO) | Cell count | 173 | 76.3 |
| Sreelakshmy et al.,2012[27] | Kerala | ST | 2010 | 15 - 45 | <12g/dl (WHO) | Cyano-haemoglobin | 346 | 78.3 |
| Kamath et al., 2013[28] | Karnataka | ST | 2012 | 15 - 49 | <12g/dl (NFHS-3) | HaemoCue | 170 | 55.9 |
| Shrinivasa, et al., 2014[29] | Kerala | ST | 2013 | 15 - 45 | <12g/dl (WHO) | Cyano-haemoglobin | 347 | 96.5 |
| Manna &Ghosh, 2014[30] | West Bengal | ST | 2009 | 18 - 49 | - | Cyano-haemoglobin | 393 | 82.5 |
| Bepari et al.,2015[31] | West Bengal | Lodha | - | 18 - 45 | <12g/dl | Haemo Cue | 120 | 92.0 |
| Nayak et al.,2016[32] | AndhraPradesh | ST | 2014 | 15 - 49 | <12g/dl | Cyano-hemoglobin | 225 | 60.9 |
| Ismail et al., 2016[33] | Kerala | ST | 2014-15 | ≥ 18 | <12g/dl (WHO) | Cyano-hemoglobin | 113 | 64.6 |
| Dabral et al.,2016[34] | Uttarakhand | Buksa | 2014 | 15 - 45 | <12g/dl | Sahli's method | 112 | 64.3 |
| Monsang& Sing, 2018[35] | Meghalaya | Garo, khasi | - | 15 - 49 | <12g/dl (WHO) | HemoCue | 150 | 92.0 |
| Mahajan et. Al. 2019[36] | Gujarat | Kukna | 2015-16 | 14 - 18 | <12g/dl (WHO) | Drabkin's hemoglobin | 168 | 45.3 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Singh, 2019[37] | Meghalaya | ST | - | 15 - 49 | <12g/dl (WHO) | Sahli's method | 103 | 89.3 |
| Rohisha et al. 2019[38] | Kerala | ST | - | 15 - 45 | <12g/dl (WHO) | HemoCue | 445 | 89.0 |
| Chowdhury& Roy 2019[39] | West Bangal | Oraon | - | 18-71 | <12g/dl (WHO) | HemoCue | 309 | 80.3 |
| Dhanuka et al. 2019[40] | West Bengal | ST | 2015-16 | 20-29 | <12g/dl (WHO) | Cell count | 48 | 62.5 |
| Mahajan et al. 2019[41] | Jharkhand | Santal | 2014-15 | 18-60 | <12g/dl (WHO) | Cyano-hemoglobin | 101 | 89.3 |
| Rokade et al. 2020[42] | Maharastra | ST | 2015-16 | 15-49 | <12g/dl (NFHS4) | HemoCue | 3923 | 54.0 |
| Total | | | | | | | 7951 | 65.3 |

## 4. Discussion

India has long-run policies and programs to curb anemia prevalence among all priority groups; despite that, it is still a country's burden [43]. The recent NFHS-5 data indicates anemia prevalence has not improved compared to NFHS-4 data across all categories [44]. Lack of anemia boosts the country's economic growth [45] and decreases faster as income increases [46].

Health for All's goal cannot be achieved fully unless given equal importance on health, especially tribal women's health and nutritional status [32]. Nutritional anemia is most common and easily avoidable [40]. Therefore, intake of micronutrient rich adequate diet is one way of the preventive method, mostly low-cost locally available diet for tribal families. In India, many studies are conducted to reveal the association between prevalence of anemia (%) and socioeconomic, environmental causes, dietary factors, poverty, illiteracy, low birth spacing, poor hygiene, and sanitation among tribal (NP-NL) women at 15 to 49 years of age [25][42].

Anemia is a significant community health problem between women age 15 – 49 during reproductive period (non-pregnant and pregnant) [47]. One-third of anemia is estimated in all women at reproductive age period (15-49 years). Globally the prevalence of anemia was 32.8 % (28.3% – 38.0%) among women in the reproductive age group and 32.5 % among women in non-pregnant on 2016. In South East Asia region, it was prevalent 45.8 % (39.1 – 51.2) in reproductive age women and 45.6% in non-pregnant women [48]. In India, according to 2016 data, anemia was 51.5% (41.48 – 58.75) and 51.43% (41.75- 58.55%) respectively among non-pregnant and reproductive age group women [44][49]. Anemia case is extensive among tribal women reproductive age group (15 – 49 years) [28]. The annual tribal health report in 2013- 14 suggested that anemia is prevalent in 65% tribal women in their reproductive age group (15-45 years)[49]. National Family Health Survey (NFHS) data from 2005 – 2020 on anemia (<12g/dl) suggests among non-pregnant women (15 – 49 yrs.) was 63.2% (2005-06), 62.8% (2015-16) and 71.7% (2019-20) respectively. Similarly, all women age 15 – 49 yrs. who are anemic was 63.2 % (2005-06), 62.5% (2015-16), and 71.4% (2019-20) respectively [44].

In 2011, WHO global report shows 48% (95% CI, 29 - 63) prevalence of anemia among Indian non-pregnant females (15-49years) at<12g/dl hemoglobin cut off level and level of public health significance of 2.5 at 8g/dl hemoglobin level (95% CI, 0.8 – 5.4) has been categorized as severe form. At the Global level, anemia prevalence was 29 % (95% CI, 23.9 – 34.8) in 2011[50]. According to NFHS 4 survey, the total sample size was 62695 tribal women, and the anemia prevalence rate was 59.9 % at <12g/dl hemoglobin level [18].

Health education and nutrition awareness are cost-effective strategies to reduce anemia prevalence [51]. Anemia is a preventable disease through dietary intervention, socioeconomic improvements etc. Dietary approach can become a successful tool in order to achieve healthy blood hemoglobin level. Vitamin-C is an important water-soluble substance, which increase non heam iron absorption by 20- 25%. It is a cost benefit dietary intervention [52]. However, a vitamin-C rich food is seasonal availability and some foods are expensive. In many tribal household a whole day's food supplies is cooked only once, providing two meals as per as 12 hours apart. Under such circumstance, it is difficult to meet ascorbic acid, iron and folic acid requirement unless a good source of these nutrients is added. Incorporation of iron

rich foods in the daily diet is the easiest and most necessary step. List of common Iron, Folic acid and vitamin-C rich foods are presented in table-5, 6, and 7 respectively [53].

**Table 5** List of common iron rich foods (ICMR, 2017) [53]

| SL No. | Iron rich foods | Scientific name | Amount (mg/100g edible portion) |
|---|---|---|---|
| 1 | Raisin dried, golden | *Vistisvinifera* | 4.26±0.6 |
| 2 | Raisin dried black | *Vistisvinifera* | 6.81±0.91 |
| 3 | Dates dry, pale brown | *Phoenix dactylifera* | 3.20±0.45 |
| 4 | Dates dry, dark brown | *Phoenix dactylifera* | 4.79 |
| 5 | Tamarind, pulp | *Tamarindusindicus* | 9.16±1.71 |
| 6 | Coriander leaves | *Coriandrumsativum* | 5.30±1.55 |
| 7 | Curry leaves | *Murray koenigii* | 8.67±0.09 |
| 8 | Mint leaves | *Menthaspicata* | 8.56±3.21 |
| 9 | Asafoetida | *Ferula assafoetida* | 15.68±4.51 |
| 10 | Cardamom green | *Elettariacardamomum* | 8.33±1.44 |
| 11 | Chillies red | *Capsicum annum* | 6.23±0.79 |
| 12 | Cloves | *Syzygiumaromaticum* | 9.41±2.10 |
| 13 | Coriander seeds | *Coriandrumsativum* | 17.64±6.74 |
| 14 | Cumin seed | *Cuminumcyminum* | 20.58±4.24 |
| 15 | Pepper, black | *Piper nigrum* | 11.91±3.48 |
| 16 | Turmeric powder | *Curcuma domestica* | 46.08±1.83 |
| 17 | Gingelly seeds black | *Sesamumindicum* | 13.9±1.60 |
| 18 | Mustard seeds | *Brassica juncea* | 13.49±3.95 |
| 19 | Egg, poultry yolk boiled | *Gallus gallus* | 4.92±0.33 |
| 20 | Poultry chicken liver | *Gallus gallus* | 9.92 |
| 21 | Goat spleen | *Capra aegagrus* | 51.41±17.21 |
| 22 | Beef spleen | *Bostaurus* | 31.68±4.50 |
| 23 | Pork spleen | *Susscrofa* | 27.21±6.43 |
| 24 | Pork liver | *Susscrofa* | 20.74±7.24 |
| 25 | Amaranth seed black | *Amaranthuscruentus* | 9.33 |
| 26 | Ragi | *Eleusinecoracana* | 4.62±0.36 |
| 27 | Rice flakes | *Oryza sativa* | 4.46±0.81 |
| 28 | Puffed rice | *Oryza sativa* | 4.55±1.03 |
| 29 | Wheat flour atta | *Triticumaestivum* | 4.10±0.67 |
| 30 | Bengal gram, dal | *Cicerarietinum* | 6.08±0.27 |
| 31 | Bengal gram whole | *Cicerarietinum* | 6.78±0.75 |
| 32 | Horse gram Whole | *Dolicusbiflorus* | 8.76±1.16 |
| 33 | Lentil whole brown | *Lens culinaris* | 7.57±0.67 |
| 34 | Soyabean brown | *Glycine max* | 8.29±0.51 |

| | | | |
|---|---|---|---|
| 35 | Beet green | *Beta vulgaris* | 5.8±0.57 |
| 36 | Fenugreek leaves | *Trigonellafoenumgraecum* | 5.69±1.37 |
| 37 | Drumstick leaves | *Moringaoleifera* | 4.56±1.09 |
| 38 | Pumpkin leaves | *Cucurbita maxima* | 5.58±0.39 |
| 39 | Onion stalk | *Allium cepa* | 3.09±0.54 |

**Table 6** List of common total folate rich foods (ICMR, 2017) [53]

| Sl. No. | Total folates (B9) rich foods | Scientific name | Amount (µ/100g edible portion) |
|---|---|---|---|
| 1 | Bengal gram whole | *Cicerarietinum* | 233±12.9 |
| 2 | Black gram whole | *Phaseolusmungo* | 134±14.2 |
| 3 | Cow pea brown | *Vignacatjang* | 231±27.3 |
| 4 | Cow pea white | *Vignacatjang* | 249 |
| 5 | Field bean white | *Phaseolus vulgaris* | 289±27 |
| 6 | Moth bean | *Vignaaconitifolia* | 349±10.8 |
| 7 | Rajmah brown | *Phaseolus vulgaris* | 330±29.6 |
| 8 | Red gram whole | *Cajanuscajan* | 229±19 |
| 9 | Soyabean brown | *Glycine max* | 297±26.1 |
| 10 | Parsley | *Petroselinumcrispum* | 197±13.9 |
| 11 | Drumstick leaves | *Moringaoleifera* | 42.89±5.31 |
| 12 | Mustard leaves | *Brassica juncea* | 110±6.6 |
| 13 | Spinach | *Spinach oleracea* | 142±10.3 |
| 14 | Tamarind leaves tender | *Tamarindusindica* | 91.82±9.56 |
| 15 | Capsicum, green | *Capsicum annuum* | 51.85±3.38 |
| 16 | Capsicum red | *Capsicum annuum* | 62.54±2.15 |
| 17 | Ladiesfinger | *Abelmoschusesculentus* | 63.68±10.76 |
| 18 | Mango ripe himsagar | *Magniferaindica* | 90.98±6.12 |
| 19 | Papaya ripe | *Carcia papaya* | 60.90±6.64 |
| 20 | Beetroot | *Beta vulgaris* | 97.37±7.06 |
| 21 | Curry leaves | *Murrayakoenigii* | 117±19.3 |
| 22 | Garlic, big clove | *Allium sativum* | 85.77±15.61 |
| 23 | Mint leaves | *Menthaspicata* | 106±6.3 |
| 24 | Poppy seeds | *Papaversomniferum* | 78.73±7.90 |
| 25 | Gingelly seeds brown | *Sesamumindicum* | 92.63±5.90 |
| 26 | Paneer | ---- | 93.31±14.37 |
| 27 | Khoa | ----- | 94.25±8.57 |
| 28 | Egg yolk raw poultry | *Gallus gallus* | 112±6.1 |
| 29 | Egg yolk boiled poultry | *Gallus gallus* | 110±6.1 |
| 30 | Sheep liver | ----- | 206±26.8 |
| 31 | Beef liver | *Bostaurus* | 1744±71.2 |

| | | | |
|---|---|---|---|
| 32 | Calf liver | ----- | 1473 |
| 33 | Aluva | *Parastromateusniger* | 1132±159 |
| 34 | Betki | *Latescalcarifer* | 2079 |
| 35 | Bombay duck | *Harpadonnehereus* | 2784 |
| 36 | Hilsa | *Tenualosailisha* | 2875 |
| 37 | Silver carp | *Hypophthalmichthysmolitrix* | 2462 |
| 38 | Carb | *Menippemercenaria* | 2304 |
| 39 | Octopus | *Octopus vulgaris* | 2087 |
| 40 | Catla | *Catlacatla* | 1926±277 |
| 43 | Rohu | *Labeorohita* | 1263±101 |
| 44 | Tiger prawns | *Macrobrachium sp.* | 1875 |

**Table 7** List of common vitamin-C rich foods (ICMR, 2017) [53].

| Sl. No. | Vitamin-C rich foods | Scientific name | Amount (mg/100g edible portion) |
|---|---|---|---|
| 1 | Agathi leaves | *Sesbaniagrandiflora* | 121 |
| 2 | Amaranth leaves, red | *Amaranth gangeticus* | 86.20 |
| 3 | Amaranth leaves | *Amaranth viridis* | 179 |
| 4 | Brussels sprouts | *Brassica oleraceavar.gemmifera* | 89.45 |
| 5 | Drumstick leaves | *Moringaoleifera* | 108±16.7 |
| 6 | Parsley | *Petroselinumcrispum* | 133±16.3 |
| 7 | Ponnaganni | *Alternantherasessilis* | 103 |
| 8 | Raddish leaves | *Raphanussativus* | 65.76±18.69 |
| 9 | Bitter gourd, jagged, smooth ridge elongate | *MomordicaCharantia* | 54.30 |
| 10 | Capsicum green | *Capsicum Annuum* | 123±7.8 |
| 11 | Capsicum red | *Capsicum Annuum* | 112±5.5 |
| 12 | Capsicum yellow | *Capsicum Annuum* | 127±12.5 |
| 13 | Drumstick | *Moringaoleifera* | 71.86±19.13 |
| 14 | Knol-Khol | *Brassica oleracea* | 64.70±10.78 |
| 15 | Mango green raw | *MagniferaIndica* | 90.24±10.47 |
| 16 | Currants, black | *Ribesnigrum* | 182 |
| 17 | Gooseberry (Amla) | *Emblicaofficinalis* | 252±30.4 |
| 18 | Guava, white flesh | *Psidiumguajava* | 214±13.6 |
| 19 | Guava, pink flesh | *Psidiumguajava* | 222±27 |
| 20 | Manila tamarind | *Pithecellobiumdulce* | 55.78 |
| 21 | Strawberry | *Fragaria X ananassa* | 50.20±4.97 |
| 22 | Cillies, green- all varieties | *Capsicum annum* | 94.07±11.67 |

Anemia is a major public health problem in India [40]. About 65% of tribal females having age between 15-49 years are anemic. A significant proportion of anemia is result of nutritional inadequacy. Therefore, anemia is preventable disease. NFHS technical report 2009 had shown average daily household intake of food stuffs by ST population does not meet RDA (%) such as green leafy vegetables 56%, other vegetables 69%, milk and milk products 14%, fats and oils 50%, sugar and jaggery 30% and pulses 75% of RDA. Average daily household nutrient intake by ST population was below than RDA (%), such nutrients are iron 44%, folic acid 51%, 36% riboflavin, 46% vitamin A and protein 78% of RDA as per tribal health report 2018, India [49].

## 5. Conclusion

From this review it is evident that, a high burden of anemia prevalence among tribal NPNL (15-49yrs.) reproductive women in India (Table-4), since 2000- 2016. So, it creates matters of concern and a severe public health thread in future. Dietary intervention, good personal hygiene and sanitation have potential impact on anemia reduction as evidence by several studies of this review. In India IFA supplementation (iron + initiatives 2013) is fail to reduce the burden of IDA at implementation level among target groups [54]. As per WHO for India, health services enhancement and food supplementation are effective strategy for anemia prevention. With that Community based screening for Hb level, monitoring of IFA distribution especially adolescent & reproductive women at ground level will produce better results. Above all these efforts along with community participation, Individual felt needs and strong political commitment will necessary to assure desire outcome very soon. Recommendation for locally available low-cost seasonal foods preferentially vitamin C, iron, folic acid rich food items etc. are guiding principles for better anemia management. This review may be best utilized as an educational tools and guidance's by community health workers, nutritionists, nurses and policy makers.

## Compliance with ethical standards

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### *Disclosure of conflict of interest*

Authors declare that there are no conflicts of interests.

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