Original Research Article

Effects of Consumption of Leafy Vegetables: Cassava (*Manihot esculenta*), Beans (*Vigna unguiculata*) and Moringa (*Moringa oleifera*) on Anemia among Pregnant Women in the Mandoul Province in Chad

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A B S T R A C T

Anemia is a global health problem that affects a significant number of people around the world, especially pregnant women. The main cause of this disease is generally an iron deficiency associated with a nutritional disorder which can lead to serious consequences for the mother and her newborn. Our work aims to determine the nutritional value of leafy vegetables, assess the rate of anemia in pregnant women and contribute to improving hemoglobin levels through the consumption of leafy vegetables. The age of the respondents is between 14 and 40 years old in the different weeks of amenorrhea. A preference is noted for the consumption of bean leaves (33%) followed by that of consuming various other leaves (cabbage, melon, sorrel, etc.) 30%. The consumption of cassava leaves is 22% and the consumption of Moringa leaves is 15%. Attendance at the CPN (Prenatal Consultation) by pregnant women is 98%. We respectively obtained the iron level in vegetables (cassava: 6.64%; beans: 56.5%; moringa: 12.5%). Iron, which is a constituent element of hemoglobin which is therefore found in these leaves, plays a vital role in the body and contributes to the fight against anemia in pregnant women.

Introduction

Leafy vegetables play an important role in diets where they provide the essential part of nutritional and medicinal needs (Kahaner *et al.,* 2005). Leafy vegetables, "safe" food, are vegetables whose part consumed corresponds to the leaves of the plant, raw or cooked, and can be cooked in a thousand and one ways (Kahaner *et al.,* 2005). From a nutritional point of view, these vegetables are very interesting since they are low in calories, but very rich in fiber, iron, calcium, omega-3, vitamins C and K and even folic acid. These exceptional qualities make leafy vegetables foods that meet the daily nutritional needs of humans particularly well, particularly pregnant women (Kahaner *et al.,* 2005). In Chad, leafy vegetables are available on the markets all year round, at low cost and are included in the composition of many

family dishes consumed by the majority of urban and rural households (Randrianatoandro, 2010). Pregnancy is characterized by changes that are accompanied by increased energy and nutritional requirements to support these maternal adaptations during pregnancy as well as for the provision of nutrients to the fetus (El-Farrash *et al.,* 2012). Thus, for adequate nutrient intake, a pregnant woman's diet should consist of carbohydrates, proteins, vitamins, minerals and water (El-Farrash *et al.,* 2012).

Nevertheless, in low- and middle-income countries (LMICs), many women living in deprived environments suffer from under nutrition and pregnancy places an additional burden on women's nutritional needs to meet the needs of the mother and developing fetus (Gernand *et al.,* 2016). Consumption habits during pregnancy are important from a public health perspective for promoting a healthy pregnancy. These consumption habits may be related to food, drinks or medications.

Good maternal nutritional status is crucial for women's health and the survival and development of their infants (Picciano *et al.,* 2003). Iron deficiency anemia could be due to a number of factors, including insufficient dietary intake of iron (Fe)-rich foods, unavailability of iron-rich foods, household food and nutrition insecurity, poor nutritional knowledge and attitudes, high iron demand during pregnancy and infestations and infections by worms such as *Ascaris*; Tapeworm; Pinworm (Darton-Hill, 2011). Furthermore, most pregnant women in developing countries begin their pregnancies with already low blood iron levels, which are exacerbated by the increased demand for iron by the developing fetus (Black *et al.,* 2013).

The work will involve proposing solutions for nutritional education interventions that could be part of the strategies that could be used to improve the nutritional knowledge and attitudes of pregnant women towards iron deficiency anemia and food consumption rich in iron. It is therefore a question of determining the nutritional value of leafy vegetables (*Manihot esculenta*; *Vigna unguiculata* and *Moringa oleifera*) with a view to reducing anemia due to iron deficiency in pregnant women in the province of Mandoul/Chad.

Materials and Methods

Study area Mandoul province is a province of Chad, a country in Central Africa. It has 637,086 inhabitants over an area of 17,000 km2. The population density of the

Mandoul province is therefore 37.5 inhabitants per km. Koumra, Moissala and Goundi are the largest cities in Mandoul province (Ocha *et al.,* 2001).

General description of the survey

This survey was carried out at the Baptiste Health Center in Koumra and that in Kemkada, specifically in the maternity services. Questionnaires are administered to patients and include information such as first and last names, age, eating habits (leafy vegetables), age of pregnancy, pregnancy number, attendance at the prenatal consultation (ANC).

Type and period of study

The survey was deployed over a period of one (1) month: namely from July 27 to August 26, 2022 at the Baptiste Hospital Health Center in Koumra and at the Kemkada Health Center. This was a prospective questionnaire survey.

Sample size

This survey was carried out on one hundred (100) pregnant women; twenty (20) midwives and one (1) doctor who voluntarily responded to this questionnaire.

Statistical analysis

We entered and analyzed our data using SPSS software version 20 and Microsoft Excel 2010 as well as Microsoft Word 2013, in order to add concrete meaning Statistical analysis we entered and analyzed our data using SPSS software version 20 and Microsoft Excel 2010 as well as Microsoft Word 2013, in order to add concrete meaning.

Physico-chemical analysis

Fibers, proteins and minerals were determined at the Food Quality and Control Study Center (CEQOCDA) in N'Djamena, Chad.

Protein analysis

Protein analysis was carried out by the Kjeldalhl method which consists of evaporation of the sample, mineralization and titration which will lead to obtaining the percentage of proteins found in the protein sample

(Rubaihayo, 2006).

Determination of fibers

The fibers were determined by the grinding and filtering method (Marie-Ève, 2005).

Determination of the content of calcium, iron and magnesium

These minerals are contained in the ash obtained. These contents were determined using Atomic Absorption Spectroscopy (Soro *et al.,* 2013). The Spectroscope is a PELKINE lmer model 3110 device brand (Connecticut, USA). An Al-Ca-Cu-Fe-Mg-Si-Zn cathode lamp was used.

Anemia test

The anemia test is carried out on a sample of 10 pregnant women at times T0 and T1 to obtain the results of Hb1 and Hb2. The time interval between T0 and T1 is 2 weeks (Berrarsa, 2021).

Results and Discussion

Age of respondents we began our questioning with the age of the parturients. The figure below shows the age distribution of these pregnant women attending these two Health Centers during this study period. In comparison with a study carried out in Constantine (Djamila, 2002) in Algeria on pregnant women, the average age 31.8 ± 4.2 years. The average of our study gives 2.43. These results are far from our results because the gap is large between the age groups.

Distribution of pregnant women by trimester

According to this figure, pregnant women whose gestational age reaches the third trimester are in the majority, i.e. 45%, followed by those in the second trimester which is 42% and finally those in the third trimester which is 13 %. These results combine those found in the study by Chaib (2019) in Algeria where 20 women represent the second trimester of pregnancy, while all the rest (80%) represent the third trimester.

Distribution of pregnant women by pregnancy number

In this part, women having carried the first pregnancy are the majority, i.e. 28%, followed by those carrying the

second pregnancy, i.e. 23%, third pregnancy (13%), fourth pregnancy (11%), fifth pregnancy (9%), those carrying the sixth and seventh pregnancy are the same, i.e. 4%, and finally those carrying the eighth, ninth and tenth pregnancy (7%). The result of this study is close to that of (Kamdem, 2012) which shows that 55.50% of women have a number of pregnancies between 2 and 3 depending on the study population.

Distribution of pregnant women by eating habits

According to our investigation into eating habits, women having consumed bean leaves (*Vigna unguiculata*) are in the majority, i.e. 33%, followed by those consuming various leaves 30%. Women having consumed cassava leaves (*Manihot esculenta*) represent 22% while those consuming Moringa leaves (*Moringa oleifera*) represent 15%. A cross-sectional study of women at 26-36 weeks gestation indicated there were low levels of vegetable and fruit consumption in south-west Sydney. Indeed, 7% revealed having respected the recommended daily consumption of vegetables (≥ 5 servings) and 13% declared having respected the recommended consumption of fruits (≥ 4 servings) (Wen *et al.,* 2010).

Distribution of pregnant women by attendance at the CPN

Pregnant women who regularly attended the CPN during each pregnancy present a percentage of 98% and those who did not regularly attend the CPN represent 2%. This study shows us that the absolute majority of the study population regularly attends CPN. This study shows a high rate compared to 17% found in Tunisia (Njah *et al.,* 1993). This rate is also low compared to the national average of 35% for pregnant women who have completed the 4 prenatal consultations recommended in Rwanda (RDHS, 2010).

Determination of the nutritional values of leafy vegetables: analyzes of proteins (determination of nitrogen) and minerals

The results of the analysis of proteins and minerals are presented in the figure 3. We notice in this figure that the protein level in Cassava leaves is 25.43% followed by dietary fiber 24.54%, calcium 19.51%, magnesium 8.40% and iron 6.64%. Indeed, Sheetal *et al.,* (2005) showed that tropical leafy vegetables are rich in protein at 31% and can help ensure food security for poor

populations.

Table.1 Age group

Age range (years)	N	%
14-20	32	32
21-25	23	23
26 -30	21	21
31-35	16	16
35-49	8	8
TOTAL	100	100

Table.2 Distribution of pregnancies by trimester

Pregnant women	N	%
Three-month 1	13	13
Three-month 2	42	42
Three-month 3	45	45
Total	100	100

Table.3 Pregnancy numbers

Pregnancy numbers	N	%
1	28	28
2	23	23
3	13	13
4	11	11
5	9	9
6	4	4
7	4	4
8	6	6
9	1	1
10	1	1
Total	100	100

Table.4 Hemoglobin level

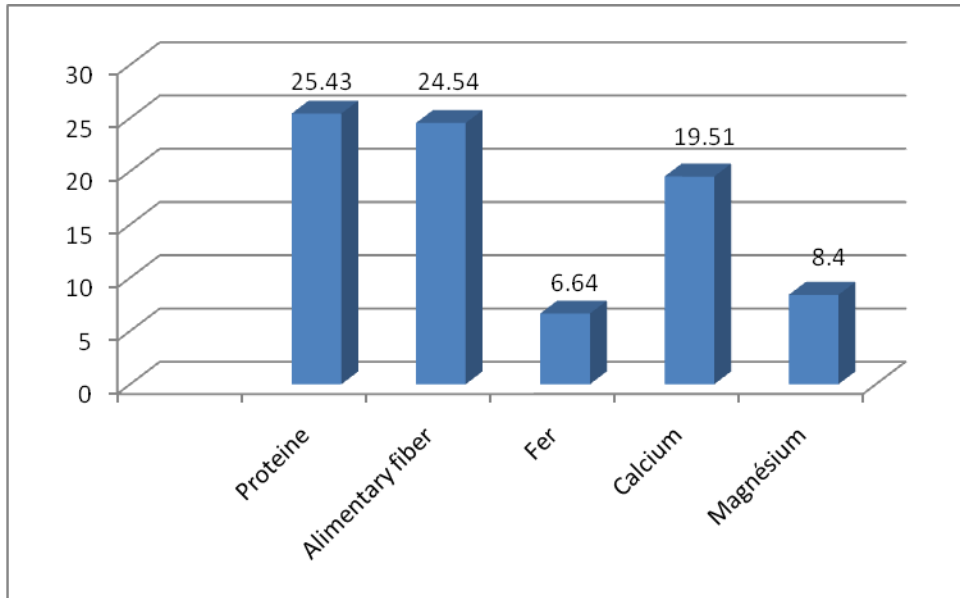| Women	Hb1	Hb2
F1	9,7	11,1
F2	10	12,3
F3	7	9,7
F4	9	11
F5	11,8	12,6
F6	9,2	7,7
F7	8,2	11,7
F8	13,1	13,8
F9	8,8	10,6
F10	9,4	11,8

Figure.1 Distribution of women according to eating habits
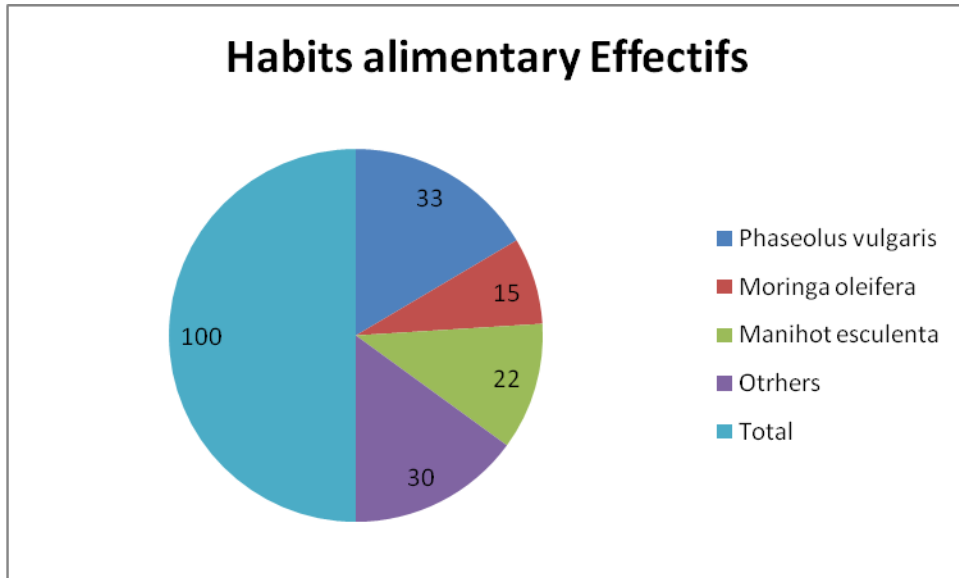
Figure.2 Distribution of women according to attendance at the CPN
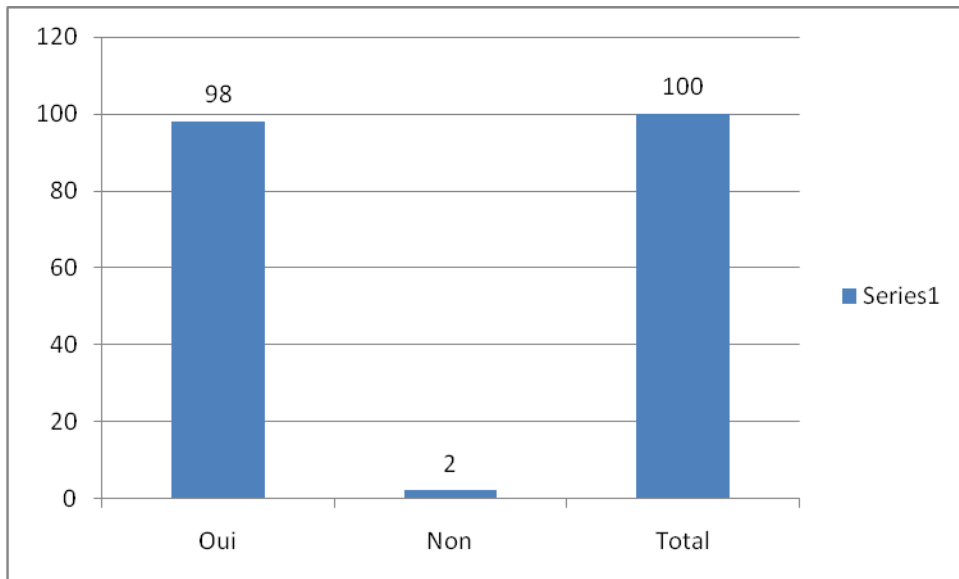
Figure.3 *Manihot esculenta*
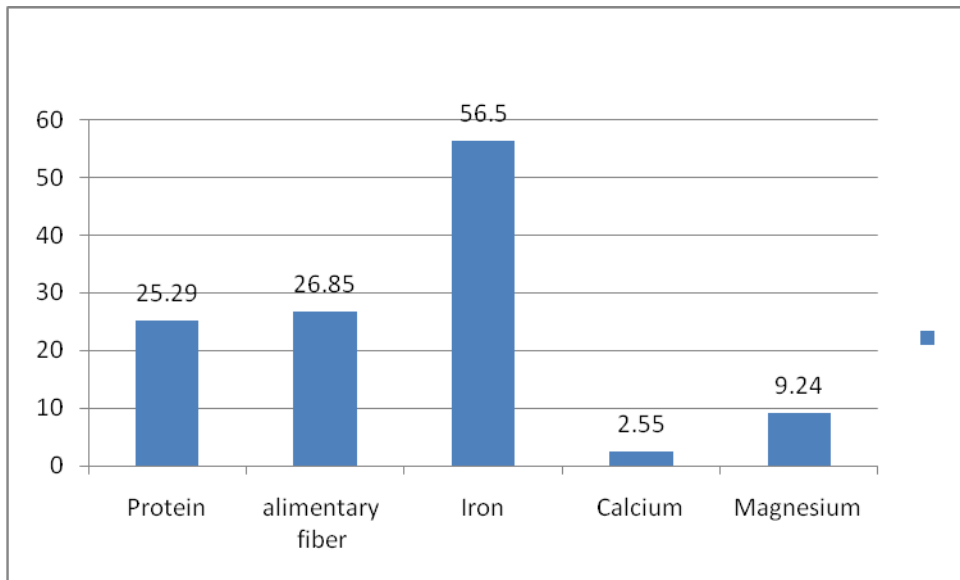

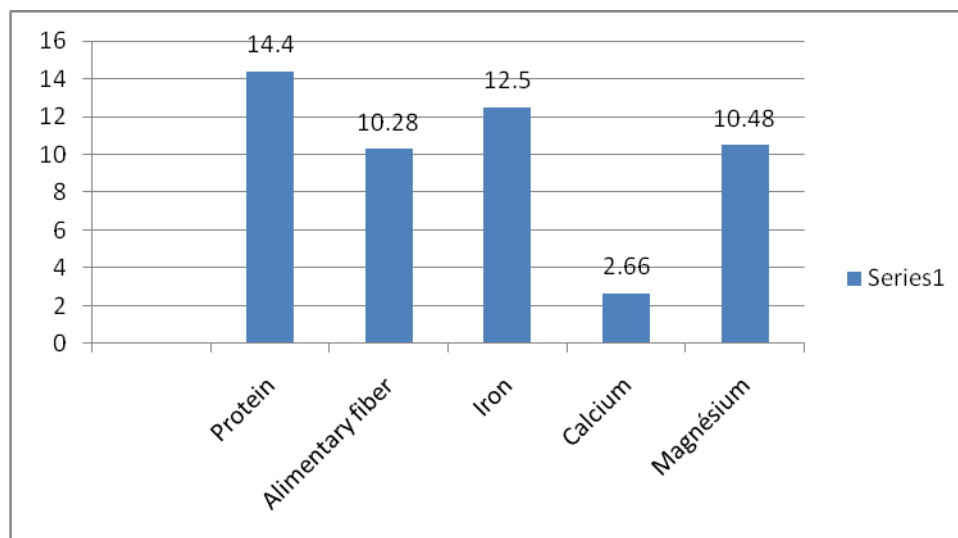
Figure.4 *Vigna unguiculata*

Figure.5 *Moringa oleifera*

They can also be used as an appreciable supplement of calories, vitamins, dietary fiber and mineral salts in the diet (Jansen *et al.,* 2004). But the excessive use of chemical fertilizers contributes to significantly reducing the protein content of vegetables (Agbo *et al.,* 2009; Anin, 2012).

According to this figure above, the iron rate is 56.5% followed by dietary fiber 26.85%, protein 25.29%, Magnesium 9.24% and Calcium 55%. While in Duranti's study (1997), bean leaves are a source of iron (4.06% or 0.569 mg per 100g). Each cell contains iron. The latter is essential for the transport of oxygen and the formation of red blood cells in the blood. It also plays a role in the production of new cells and hormones. The bean is also a source of other important minerals and trace elements: calcium, copper, iodine, phosphorus, sodium, zinc (Du *et al.,* 2014).

The figure tells us about the protein rate at 14.04% compared to Iron which is 12.5%, Magnesium is at 10.48% while dietary fiber is 10.28%. The result of this study shows us that the level of proteins and minerals in the leaves of *Moringa oleifera* is therefore able to improve the hemoglobin level in pregnant women. These results explain the importance of these leaves as in a study in Egypt where *Moringa oleifera* leaves are a vegetable of good nutritional quality and are one of the best tropical vegetables. They are an excellent source of protein with average contents varying between 19-35% dry matter DM (Makkar and Becker, 2001). Mature

leaves contain less protein than young leaves due to their high fiber content. Minerals occupy a modest part of the dry matter of *Moringa oleifera* leaves with contents of 0.6 to 11.42% DM (Makkar and Becker, 2001).

Evaluation of the anemia rate of pregnant women. The test is carried out on 10 pregnant women whose results are recorded in figure 6.

In this study, we note: Average value of pregnant women in T0: 9.62; in T1: 11.23. Average value for each woman in experiment: F1: 10.4. F2: 11.15. F3:8.35. F4:10. F5: 12.2. F6: 8.45. F7:9.95. F8:13.45. F9:9.7. F10:10.6.

In this study, we note that there is a high content of hemoglobin level before and after submitting women to a leafy vegetable diet with a percentage of 90% and this result is significant with $p<0.05$ and varies from 0.003 to 0.004. In this study, we note that there is a high content of hemoglobin level before and after submitting women to a leafy vegetable diet with a percentage of 90% and this result is significant with $p<0.05$ and varies from 0.003 to 0.004.

There is a big difference with other studies in Mali which found severe anemia at 69.9%, 29.20% and 61.4% respectively. According to the EDS in 2011 in Cameroon, severe anemia represents 1.1% and moderate 25.5% in women. In the Kolda region (Senegal) the prevalence of anemia in pregnant women of childbearing age is 55, with anemia and pregnancy. Epidemiological-

clinical aspects at CHU Gabriel Toure, moderate anemia, 36.8% with mild anemia and 12.2% with severe anemia (Diégane, 2018). According to the current 2010-2011 EDS, in Senegal, the prevalence of anemia among women is 54%, including 61% among pregnant women, 49% among those who are breastfeeding (EDS-MICS, 2010-2011). Overall, 46% of women in Guinea Conakry suffer from anemia, 65% from anemia in pregnant women, 2% from severe anemia and 22% from sub-moderate anemia (EDS –V, 2018).

Author Contributions

Makalao Mouti Marceline: Investigation, formal analysis, writing—original draft. Brahim Boye Otchom: Validation, methodology, writing—reviewing. Allaissem Madjadjingar:—Formal analysis, writing—review and editing. Alfred S. Traore: Investigation, writing—reviewing.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

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