MedCrave Step into the World of Research International Journal of Complementary and Alternative Medicine

Research Article

Open Access CrossMark

# Effect of biofortified bars with heme iron "Nutribarra Andina" in the prevention and control of anemia in children under 5 years in Chugay and Curgos, La Libertad, Peru. An observational study-cross-sectional study

## Abstract

**Background:** A nutritional supplement has been developed based on Andean grains enriched with chicken blood called NUTRIBARRA ANDINA, but its effect on the control of anemia is not known.

**Objectives:** To evaluate the effect of consuming NUTRIBARRA ANDINA to increase hemoglobin levels in children under 5 years of age in Chugay, La Libertad, Peru.

**Methods:** The study was carried out in two groups of 48 children under 5 years of age, diagnosed with childhood anemia, a control group and the other experimental group that consumed NUTRIBARRA ANDINA, the hemoglobin level was determined at 30, 60 and 90 days after starting the consumption of this nutritional supplement, the information was statistically analyzed using ANOVA and Tukey's mean comparison test $p<0.05$.

**Results:** No statistical differences were found for hemoglobin levels before starting the study between both groups, but they were different $p<0.01$ for hemoglobin levels at 30, 60 and 90 days after starting the study with hemoglobin levels average in the experimental group of $10.99 \pm 0.28$, $11.19 \pm 0.30$ and $11.48 \pm 0.24$ respectively and in the control group it was $9.82 \pm 0.23$, $10.29 \pm 0.24$ and $10.61 \pm 0.21$ respectively. In the experimental group differences were found among the level of hemoglobin at 30, 60 and 90 days with the initial level, but no differences were found between 30 and 60 and 60 and 90 days. At 90 days, 81.82% of the experimental group recovered from anemia and 14.58% in control group.

**Conclusions:** The interday consumption of NUTRIBARRA ANDINA increased hemoglobin levels in the children of the experimental group, allowing 81.82% of them to overcome anemia 90 days after starting its consumption.

**Keywords:** anemia, hemoglobin, nutrition, heme iron, nutribarra

Volume 18 Issue 1 - 2025

Ronal Otiniano Villanueva,[1] Felipa Pinedo Valverde,[2] Juan M Pérez Vasquez,[3] Manuel Gastelo Benavides,[4] William Huamanchay Rodriguez[5]

1Agricultural Research Project Coordinator, NGO Asociación Pataz, La Libertad, Peru
2Nutritionist, NGO Asociación Pataz, La Libertad, Peru
3Executive Secretary, NGO Asociación Pataz, La Libertad, Peru
4Consultant, International Potato Center, Lima, Peru
5Agricultural Research, Technical Assistant, NGO Asociación Pataz, La Libertad, Peru

**Correspondence:** Ronal Otiniano Villanueva, Agricultural Research Project Coordinator, NGO Asociación Pataz, La Libertad, Peru, Tel+51 998-484-702, Email rotiniano@asociacionpataz.org.pe

**Received:** January 19, 2025 | **Published:** February 3, 2025

## Introduction

According to the World Health Organization (WHO),[1] iron deficiency anemia is a global public health and nutritional problem, causing hemoglobin (Hb) levels in the blood to be below normal levels, affecting 2 billion people worldwide, particularly women and children especially in developing countries.[2] In Peru, anemia remains widespread, with a prevalence of 39% in children aged 6 to 35 months and 19% in women aged 15 to 49 years, being even more common in rural areas of the Andean zone, with an average of 49% in children and 20% in women.[3] There are studies that show that anemia in infants affects psychomotor development and that this effect would be maintained, despite correcting the anemia, observing, in the long term, a decrease in performance in the cognitive, social and emotional sphere, it also causes a decrease in myoglobin levels, reducing the aerobic capacity of the muscle fiber with a high risk of mortality of 4.3 times more than non-anemic children.[4–6]

When hemoglobin levels are below 11 mg/dL, and 11.5 mg/dL for children from 06 to 50 months and 5 years respectively, it is considered an anemia disorder because the number of erythrocytes is low and the oxygen carrying capacity of the blood is insufficient to meet the needs of human metabolism. Anemia was classified as mild, with levels greater than 10 mg/dL, moderate between 7 and 9.9 mg/dL and severe below 7 mg/dL.[7,8]

Nutritional intervention is essential for the treatment of anemia, according to studies carried out, adequate nutritional intervention with iron-based nutritional supplements, helps in the treatment of anemia in children from 6 to 55 months of age, contributing to the reduction of anemia.[9,10] Supplementation constitutes an important strategy against micronutrient deficiency problems, because it allows high-risk groups to be specifically reached and provides the nutrient contribution that help the deficiency to be corrected more quickly; However, they also entail a series of technical and practical barriers such as difficulties in distribution, lack of information about the use and benefits of the supplement, low adherence and side effects.[11]

Also, WHO recommends the use of iron supplements or home-made fortifiers to improve hemoglobin levels and reduce the prevalence of anemia in children aged one to five years in low-income countries. Home-made fortifiers and foods fortified with heme iron in small quantities they can have positive effects on the nutritional status of children.[12]

There are two types of iron, heme iron which comes from animal origin (visors, red meat, dark meat fish), is more easily absorbable

in our body between 15% to 35%, which is why it is considered of higher quality. and better assimilation, unlike non-heme iron of plant origin (legumes, dark green vegetables), its absorption will be affected by several factors such as the interaction with other nutrients such as fiber, oxalates, etc., so it is necessary to consume it accompanied by vitamin C to improve its absorption in the human body.[13] Various investigations have been carried out on the use and effect of nutritional bars with supplemental heme iron both in Peru and in other countries around the world.

In a study carried out in Puno, Peru (2018) to measure the effect of consuming bovine blood on the increase in hemoglobin levels in children from 18 to 36 months, four treatments were evaluated, one with bovine blood in children with anemia, a second group in children without anemia, another only with multimicronutrients and a control group, they found that children who consumed bovine blood and had anemia increased their hemoglobin content by 1,783 mg/dL, those without anemia increased by 1.010 mg/dL and children who only consumed multimicronutrients increased by 0.510 mg/dL.[14]

In 2021 in La Libertad, Peru, a study was carried out to determine the effect of a nutritional bar based on quinoa (*Chenopodium quinoa*), and kiwicha (*Amaranthus caudatus*), enriched with heme iron from bovine blood on hemoglobin levels. in children from 4 to 10 years old. Finding that children who consumed the nutritional bar had endLine Hb values of 14 g/dL and children who did not consume the bar who had 11.85 g/dL of hemoglobin.[15]

In another study conducted in India in 2019 to investigate the effect of two products used for the control of iron deficiency anemia in women: Hemocare Syrup and Hemocare Tablets compared with a placebo. Statistically significant differences were found between initial hemoglobin content and 30 days later in women taking Hemocare syrup or tablets, but no differences were found in treatment with placebo. The hemoglobin content increased from 9.08 and 9.68 g/dL to 12.46 and 12.90 g/dL with Hemocare syrup and tablets respectively.[16]

Other nutritional supplements have also been used, such as spirulina algae (*Spirulina plantensis*), which was added to nutritional bars based on cereals such as rice (*Oryza sativa*), corn (*Zea mays*) and beans such as chickpeas (*Cicer arietinum*) and peanuts (*Arachis hypogaea)*. L.), in addition, a liquid base of ghee butter, liquid glucose and brown sugar was added, which was very acceptable due to its color, flavor and texture. These bars were tested in children against bars without spirulina, finding that spirulina increased by 167% compared to the bar without spirulina and this can be a great alternative to fortify some foods to improve their nutritional content.[17]

It is very important to take into account the acceptability of these bars, blood may have an unpleasant taste to the human palate. In a study carried out in Huaura, Peru (2019), three types of bars, all enriched with chicken blood and covered with natural dark chocolate, were evaluated to determine acceptability in children from 4 to 7 years of school age, finding that 90 % of the children rated it as "I like it a lot", with the same texture, aroma and flavor in the three types of bars, but they also mention that cocoa inhibits the absorption of iron between 30 and 60% due to the presence of tannins that form insoluble complexes with iron, making its absorption difficult. By the human organism, so this bar would not be as effective as a treatment against childhood anemia.[18]

The NGO Asociación Pataz, committed to the fight against childhood anemia, has been developing ventures with small associations of producers that contribute to reducing the prevalence of anemia in the districts of Curgos and Chugay in the province of Sánchez Carrión through strengthening the capacities of mothers with children under 5 years of age and promoting the consumption of superfoods that contribute to having healthy, strong, intelligent children without anemia, a product of which has developed a nutritional bar based on local plant products mixed with chicken blood called NUTRIBARRA ANDINA to help control anemia.

The objective of this study was to evaluate the effect of NUTRIBARRA ANDINA with heme iron, in reducing the levels of childhood anemia in children from one to 5 years of age in the districts of Chugay and Curgos in the La Libertad region, Peru.

## Methods

### Population participating in the study

This study was carried out from August to October 2022 in the districts of Curgos and Chugay of the province of Sanchez Carrion, La Libertad, Peru, with similar geographic, demographic, social and child well-being characteristics (Table 1). We worked with children from 1 to 5 years of age diagnosed with childhood anemia, there was a control group of 48 children from the Curgos district and an experimental group also with 48 children from the Chugay district (Table 2, Figure 1).[19]

**Table 1** Locations where the study was carried out

| District | Province | Region | Altitude m.a.s.l. | Latitude | Longitude |
|---|---|---|---|---|---|
| Curgos | Sánchez Carrion | La Libertad | 3225 | 7°51′36.9″ S | 77°56′37.03″ W |
| Chugay | Sánchez Carrión | La Libertad | 3371 | 7°46′56.5″ S | 77°52′3.43″ W |

**Table 2** Means and standard deviation of the age of children in the study

| Group | n | Mean | Standard deviation |
|---|---|---|---|
| Control | 48 | 1.77 | 0.97 |
| Experimental | 48 | 2.35 | 0.91 |
| Total | 96 | 2.06 | 0.98 |

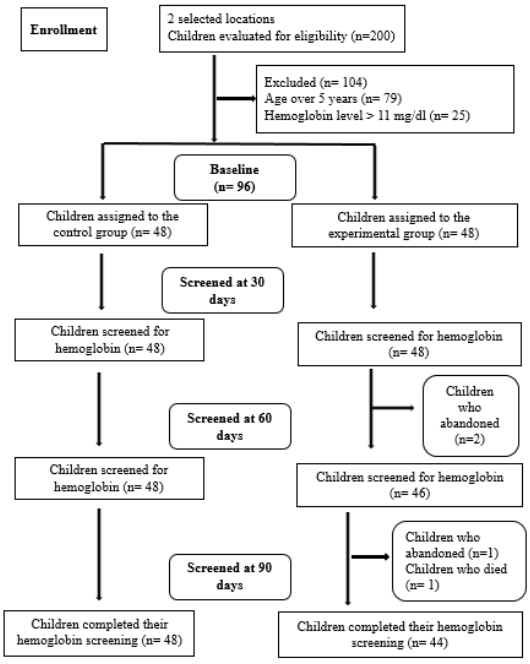


**Figure 1** General study diagram.

## Preparation of nutribarra andina

The bars biofortified with heme iron that were evaluated in this study were manufactured locally by the Alto Andina Agrarian Cooperative Chugay, located in the Chugay district, Sánchez Carrión Province, La Libertad region, Peru. The composition of NUTRIBARRA ANDINA is shown in Table 3.

**Table 3** Composition of NUTRIBARRA ANDINA (50 grams), enriched with heme iron

| Components | Unit of measure | Quantity | % |
|---|---|---|---|
| Quinoa expanded | Grams | 5 | 9 |
| Kiwicha expanded | Grams | 5 | 9 |
| Coconut grated | Grams | 3 | 5 |
| Cañihua expanded | Grams | 4 | 7 |
| Coconut oil | Milliliters | 10 | 18 |
| Panela | Grams | 10 | 18 |
| Maple honey (Acer saccharum subsp. Skutchii) | Milliliters | 6 | 11 |
| Bee honey | Grams | 2 | 4 |
| Dehydrated chicken blood | Grams | 7 | 13 |
| Salt | Grams | 1 | 2 |
| Vanilla essence | Grams | 1 | 2 |
| Cinnamon powder | Grams | 1 | 2 |

NUTRIBARRA ANDINA was prepared with a dry base made from Andean grains such as quinoa (*Chenopodium quinoa*), kiwicha (*Amaranthus caudatus* L.) and Cañihua (*Chenopodium pallidicaule*), dehydrated chicken blood, panela, salt and cinnamon powder, the which was mixed with a liquid base composed of coconut oil (*Cocos nucifera* L.), maple honey (*Acer saccharum* subsp. *Skutchii*), honey, vanilla essence and water, prepared on fire at a temperature of 70°C for 10 minutes. The mixture of the dry and liquid base was placed in silicone mold trays to form the 50-gram bars, then it was placed in the oven preheated to 180 °C for 20 minutes, finally it was left to cool and packed in plastic bags. Vacuum sealed and labeled. To determine the nutritional composition, a sample of 800 grams of NUTRIBARRA ANDIA was sent to the food analysis laboratory of the Nutritional Research Institute (IIN) in Lima, Peru, taking subsamples of 100 grams for the respective analysis (Table 4).

**Table 4** Nutritional composition of the biofortified bar "NUTRIBARRA ANDIN"A enriched with heme iron (100 grams) 2022

| Components | Unit | Quantity |
|---|---|---|
| Fat | Grams | 15.1 |
| Protein | Grams | 11.1 |
| Crude Fiber | Grams | 1.4 |
| Iron | Milligrams | 21 |
| Ashes | Grams | 1.3 |
| Moisture | Grams | 5.5 |
| Carbohydrates | Grams | 67 |
| Total energy | Kcal | 448.3 |

## Treatments

The treatments were two:

I. Experimental Group, of 48 children, who consumed NUTRIBARRA ANDINA in the district of Chugay.

II. Control Group, of 48 children, who did not consume NUTRIBARRA ANDINA in the Curgos district.

## Evaluation of hemoglobin level

The baseline hemoglobin data recorded in the clinic history of the children treated at the Curgos and Chugay health centers were taken, both in the control and experimental groups. In the experimental group, a prior meeting was held with the parents, where the benefits of its consumption were socialized, then the mothers proceeded to sign an informed consent to authorize the carrying out of the hemoglobin screenings monthly to their children to evaluate the effect of consuming NUTRIBARRA ANDINA (10.5 mg heme iron), which was provided every other day for three months to children from one to five years of age, with the aim that children do not get tired by consuming a single food every day, observing that there was no rejection of consuming NUTRIBARRA ANDINA due to its flavor, texture and smell. During the study, training was carried out through educational and demonstration sessions on healthy lifestyles, anemia prevention and iron-rich foods for the children's mothers; In addition, home visits were made to deliver the nutritional bars and provide training to the family.

The monthly hemoglobin screening in the experimental group was carried out 30, 60 and 90 days after starting the consumption of NUTRIBARRA ANDINA, during the months of August, September and October 2022, the determination of the hemoglobin level was carried out by taking a capillary blood sample by trained personnel from the NGO Pataz Association in collaboration with the staff of the Chugay health center. It was decided to take capillary blood samples, which are more practical than venous blood samples, which are more traumatic for children under 5 years of age. The sample was analyzed through a portable hemoglobinometer,[20,21] brand HEMOCONTROL, model EKF DIAGNOSTIC, manufactured by the company EKF DIAGNOSTIC of origin Germany in 2015.[22]

In the control group, hemoglobin levels were determined through the medical history of the Curgos health center, who performed the exams every 30 days, Hemoglobin levels from medical history were also determined with the same method and equipment used in the experimental group.

The adjustment of hemoglobin levels was carried out according to the altitude level of the intervention site, both in the control group of Curgos and the experimental group of Chugay. The adjusted hemoglobin was determined by subtracting from the observed hemoglobin 2.1 m/dL in Curgos and 2.3 mg/dL in Chugay.[23,24]

Anemia was classified according to the following hemoglobin level ranges:

Severe: < 7.00 mg/dL

Moderate: from 7.00 to 9.99 mg/dL

Mild: from 10.00 to 10.99 mg/dL

Normal: from 11.00 to 16.00 mg/dL.

## Statistical analysis

A one-way analysis of variance was performed to compare the initial hemoglobin levels and at 30, 60 and 90 days after the start of consumption of NUTRIBARRA ANDINA, hypothesis 1 was that the initial hemoglobin levels were statistically equal in the two groups, to To avoid previous effects that could alter the final result, hypothesis 2 considered that in the experimental group hemoglobin levels increased due to the consumption of NUTRIBARRA ANDINA enriched with heme iron. The following mathematical model was used:[25,26]

$$Yij = \mu + \alpha j + \varepsilon ij$$

**Citation:** Otiniano R, Valverde FP, Vasquez JMP, et al. Effect of biofortified bars with heme iron "Nutribarra Andina" in the prevention and control of anemia in children under 5 years in Chugay and Curgos, La Libertad, Peru. An observational study-cross-sectional study. *Int J Complement Alt Med.* 2025;18(1):33–38. DOI: 10.15406/ijcam.2025.18.00722

where

Yij = Hemoglobin level of the ith child under treatment j.

μ = total average.

αj = effect of the jth treatment.

εij = error associated with the ith child under the jth treatment.

The comparison of the means of both groups was carried out with the Tukey test with a significance value of $p < 0.05$ at a confidence level of 95%. The results of hemoglobin levels are presented in tables and figures where the experimental group is compared with the control group. The statistical programs R and IBM SPSS Statistics V. 27, Excel and Microsoft Power Point were used.

## Results

The trial began with two groups of 48 children from the experimental group, who remained until 30 days after starting the consumption of NUTRIBARRA ANDINA, then for screening, at 60 and 90 days there were only 46 and 44 children, respectively, two of them went to live outside Chugay and one died due to respiratory problems. In the control group, the 48 children remained until 90 days. The analysis of variance for hemoglobin levels in each screening shows that in the initial screening no significant statistical differences were found for the treatments studied. In the screenings at 30, 60 and 90 days, highly significant statistical differences were found ($p <0.01$), indicating that hemoglobin levels were different between the control and experimental groups. The coefficients of variation were in the range of 6.32 to 8.70%, values within the expected range for this study (Table 5).

**Table 5** Analysis of variance for the hemoglobin level during four screenings at 0, 30, 60 and 90 days after starting the consumption of NUTRIBARRA ANDINA. Curgos and Chugay, La Libertad, Peru. 2022

| Sources of variation | d.f. | Mean squares | | | | | |
|---|---|---|---|---|---|---|---|
| | | Initial | 30 days | g.l. | 60 days | g.l. | 90 days |
| Treatments | 1 | 0.36 | 32.78 ** | 1 | 19.02** | 1 | 17.51** |
| Error | 94 | 0.39 | 0.76 | 92 | 0.87 | 90 | 0.57 |
| C.V.% | | 6.32 | 8.4 | | 8.7 | | 6.84 |

d.f = Degrees of freedom; ** Statistical significance $p<0.01$.

The combined analysis of variance for the hemoglobin levels in the four screenings (Table 6) showed highly significant statistical differences ($p<0.01$) for the screenings, indicating that the hemoglobin levels were different in each screening, likewise, for the effect of the treatments studied, the interaction between screenings and treatments was highly significant, indicating that some children probably presented different hemoglobin levels, some went up, others went down, as the days of consumption of NUTRIBARRA ANDINA increased, especially in the control group. The coefficient of variability was 7.41%, being within the acceptable range.

**Table 6** Combined analysis of variance of hemoglobin level during 4 screenings. Curgos and Chugay, La Libertad, Peru 2022

| Sources of variation | d.f. | Mean squares |
|---|---|---|
| Hemoglobin screenings | 3 | 21.33** |
| Treatments | 1 | 46.89** |
| Treatments x Hb Screenings | 3 | 7.72** |
| Combined error | 370 | 0.65 |
| C.V. % | | 7.41 |

d.f. = Degrees of freedom; ** Statistical significance $p<0.01$.

Table 7 shows the comparison of the mean hemoglobin levels of the control and experimental groups. In the initial hemoglobin screening before starting the study, the control group had an average of 9.99 mg/dL of hemoglobin and the experimental group had 9.87 mg/dL of hemoglobin, which were not statistically different, the hemoglobin levels at 30, 60 and 90 days were statistically different, with the values of the experimental group being higher than those of the control group, this indicates the effect of NUTRIBARRA ANDINA to increase the level of hemoglobin in children under 5 years of age in the Chugay district. The ranges of hemoglobin levels are presented in Table 8, where we observe that in the control group the hemoglobin level increased from 7.80 to 12.60 mg/dL, with a mean increase of 0.62 ± 0.30 mg/dL since screening. initial until 90 days after starting the consumption of NUTRIBARRA ANDINA, in the experimental group the hemoglobin level increased from 7.00 to 13.60 mg/dL, with a mean increase of 1.61 ± 0.28 mg/dL from the initial screening to 90 days after starting the consumption of NUTRIBARRA ANDINA (Table 8, 9).

**Table 7** Comparison of hemoglobin levels in mg/dL using Tukey's mean comparison test ($p<0.05$), Curgos and Chugay, La Libertad, Peru 2022

| Treatments | Days | | | |
|---|---|---|---|---|
| | Initial | 30 | 60 | 90 |
| Experimental Group | 9.87 ± 0.17 a | 10.99 ± 0.28 a | 11.19 ± 0.30 a | 11.48± 0.24 a |
| Control Group | 9.99 ± 0.19 a | 9.82 ± 0.23 b | 10.29 ± 0.24 b | 10.61 ± 0.21 b |

Treatments with the same letter are statistically equal.

**Table 8** Range of hemoglobin levels at 0, 30, 60 and 90 days after starting the consumption of NUTRIBARRA ANDINA. Curgos and Chugay, La Libertad, Peru. 2022

| Hemoglobin Screening (days) | Hemoglobin level mg/dL | |
|---|---|---|
| | Experimental Group | Control Group |
| Initial | 7.00 - 10.70 | 7.80 - 10.90 |
| 30 | 9.00 - 13.30 | 7.00 - 10.90 |
| 60 | 8.70 - 13.60 | 8.20 - 12.00 |
| 90 | 9.50 - 13.50 | 9.00 - 12.60 |

Comparing the hemoglobin levels within each group, Tukey's mean comparison test ($p<0.05$) at a confidence level of 95% shows that in the experimental group the hemoglobin levels at 30, 60 and 90 were statistically different from the initial hemoglobin level, but no differences were found between 30 and 60 days and 60 and 90 days. However, the increase in hemoglobin level in the experimental group (1.61 ± 0.28 mg/dL) was 2.5 times the increase in hemoglobin level in the control group (0.62 ± 0.30 mg/dL), due to the consumption of NUTRUBARRA ANDINA (Table 9).

In the initial screening of the experimental group, there were 31 children with mild anemia (64.58%) and 17 with moderate anemia (35.42%), after 30 days there were 25 children (52.08%) without anemia (normal hemoglobin), there was an increase to 56.52% of children without anemia 60 days after starting to consume NUTRIBARRA, this value increased to 36 of 44 children (81.82%) without anemia 90 days after consuming NUTRIBARRA ANDINA (81.82%) as seen in Figure 2. In the control group, at 60 days, 10.42% and at 90 days, 14.58% of the children were not anemic, probably because these children consumed the ferrous sulfate provided by the Ministry of Health (MINSA) of Peru. However, the percentage of children in the experimental group who recovered from anemia (> 11.00 mg/dL) was 5 times more than in the control group.

**Citation:** Otiniano R, Valverde FP, Vasquez JMP, et al. Effect of biofortified bars with heme iron "Nutribarra Andina" in the prevention and control of anemia in children under 5 years in Chugay and Curgos, La Libertad, Peru. An observational study-cross-sectional study. *Int J Complement Alt Med.* 2025;18(1):33–38. DOI: 10.15406/ijcam.2025.18.00722

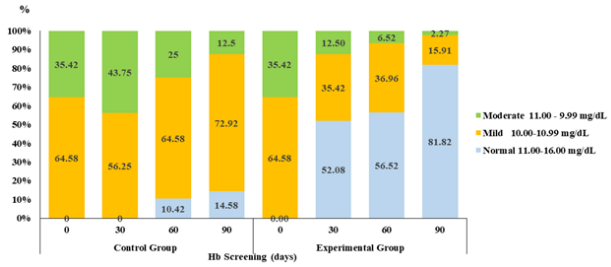


**Figure 2** Percentage of children in the experimental and control group, according to hemoglobin levels at 0, 30, 60 and 90 days.

## Discussion

Anemia is a disorder in which the number of erythrocytes and, consequently, the oxygen-carrying capacity of the blood is insufficient to meet the body's needs, considering that iron deficiency in the blood is the main cause of anemia. However, it can be caused by other nutritional deficiencies (folic acid, vitamin B12 and vitamin A), acute and chronic inflammation, parasitosis and hereditary or acquired diseases that affect hemoglobin synthesis and the production or survival of cells erythrocytes.[27]

In this study it was possible to corroborate that NUTRIBARRA ANDINA enriched with chicken blood that has heme iron, is rich in iron with a value of 210.50 ppm and 11.10 g of protein/100 g of sample, as seen in table 3. Agreeing With the results found by Lupaca, Lizarraga and Rosas[14,15,18] they found that the inclusion of blood with heme iron in nutritional supplements increases the iron and protein content.

The analyzes of variance (Table 5) show us that in the screening before starting the study there were no significant statistical differences between the two groups, assuming that the two groups are initially equal in their hemoglobin content,[25] which allows us infer that the differences in hemoglobin levels between the two groups found in subsequent screenings are not influenced by the differences that may have existed initially, but are probably due to the effect of the consumption of NUTRIBARRA ANDINA.[23] The level of hemoglobin at 30, 60 and 90 days was statistically different between the two groups, the experimental group presented a higher level of hemoglobin compared to the control group, probably due to the effect of NUTRIBARRA ANDINA, as seen in table 7, analyzing the positive increase in the experimental group, it is found that the hemoglobin levels at 30, 60 and 90 days are statistically different ($p<0.01$) from the initial level, however the hemoglobin level at 30 days is not significant compared to screening at 60 days, but it is statistically different with the hemoglobin levels at 90 days, the hemoglobin level at 60 and 90 days was statistically non-significant (Table 9), probably due to the accumulation due to the effect of consumption of the NUTRIBARRA ANDINA, which reports a significant increase at the beginning of treatment and then slowly increased, probably due to the presence of some factors that make up NUTRIBARRA ANDINA, whose effects should be studied later.

The significant interaction between the screening dates and the groups shown in Table 6 would indicate that the increase in hemoglobin level in the experimental group was always ascending from the initial screening to 90 days, but in the control group shows a decrease in the average hemoglobin level at 30 days with respect to the initial screening as can be seen in Table 7.

The increase in hemoglobin level from the beginning to 90 days after consuming NUTRIBARRA ANDINA, in the control group was 0.62 ± 0.30 mg/dL and in the experimental group it was 2.5 times more with 1.61 ± 0.28 mg/dL (Table 9), probably due to the consumption of NUTRIBARRA ANDINA enriched with heme iron contained in chicken blood. At 90 days in the experimental group, the average hemoglobin level was 11.48 ± 0.24 mg/dL and in the control group it was 10.61 ± 0.21 mg/dL, corroborating that the consumption of this nutritional supplement had a positive effect on the control of anemia in children under 5 years of age in the town of Chugay, coinciding with the results obtained by[14–16,18] who report that in their studies of treatment of anemia with nutritional bars they achieved results positive.

**Table 9** Comparison of hemoglobin levels and the increase through the Tukey test ($p<0.05$), at 0, 30, 60 and 90 days after starting the consumption of NUTRIBARRA ANDINA. Curgos and Chugay, La Libertad, Peru. 2022

| Hemoglobin Screening (days) | N | Hemoglobin mg/dL | | Increased hemoglobin level mg/dL | |
|---|---|---|---|---|---|
| | | Control Group | Experimental Group | Control Group | Experimental Group |
| 90 | 96 | 10.61 ± 0.21 a | 11.48 ± 0.24 a | 0.62 ± 0.30 a | 1.61 ± 0.28 a |
| 60 | 96 | 10.29 ± 0.24 c | 11.19 ± 0.30 ab | 0.25 ± 0.30 ab | 1.32 ± 0.29 a |
| 30 | 93 | 9.82 ± 0.23 ab | 10.99 ± 0.28 b | -0.18 ± 0.31 b | 1.12 ± 0.32 a |
| Initial | 92 | 9.99 ± 0.19 bc | 9.87 ± 0.17 c | 0 | 0 |

Treatments with the same letter are statistically equal.

The hemoglobin level ranges presented in Table 8 for each screening indicate that in the control group at 60 and 90 days there were 5 and 7 children with more than 11 mg/dL of hemoglobin (Figure 2), leaving the anemia, probably due to the treatment for anemia provided by the Peruvian Ministry of Health. In the experimental group, 30, 60 and 90 days after starting the consumption of NUTRIBARRA ANDINA, 25, 26 and 36 (81.82%) children managed to increase their hemoglobin levels, allowing them to overcome anemia, as a result of the consumption of this supplement. nutritional enriched with heme iron (Figure 1,2), however, six children, despite increasing their hemoglobin levels, did not manage to overcome anemia and another 2 did not increase their hemoglobin (Figure 2). In the control group, at 90 days, 7 children managed to overcome anemia and 41 reached 90 days with moderate or mild anemia, as seen in Figure 2. The children who managed to overcome anemia were probably due to the treatmentfor anemia provided by the Ministry of Health of Peru.

## Conclusion

The results of this study show us that the incorporation of products that are not commonly consumed, such as chicken blood, can be beneficial to combat anemia, since its nutritional content is taken advantage of by giving these wastes appropriate use. The results of this study show us that the consumption of NUTRIBARRA ANDINA based on Andean grains and chicken blood contributes to the control of childhood anemia in children under 5 years of age, also

**Citation:** Otiniano R, Valverde FP, Vasquez JMP, et al. Effect of biofortified bars with heme iron "Nutribarra Andina" in the prevention and control of anemia in children under 5 years in Chugay and Curgos, La Libertad, Peru. An observational study-cross-sectional study. *Int J Complement Alt Med.* 2025;18(1):33–38. DOI: 10.15406/ijcam.2025.18.00722

giving added value to quinoa, kiwicha and cañihua, contributing to the protection of the environment through the use of waste such as chicken blood, improving the quality of life of vulnerable and low-income populations.

## Acknowledgments

We thank the entire technical and administrative team of Asociación Pataz y la Cía. Poderosa S.A., for its support in carrying out this study, to the District Municipality of Chugay, to the Sánchez Carrión Health Network, especially to the Health Centers of Chugay and Curgos for their support in the hemoglobin analyzes and to the mothers of family of the children who participated in this research work.

## Conflicts of interest

The authors report no conflicts of interest.

## Data linking

https://data.cipotato.org/dataset.xhtml?persistentId=doi:10.21223/OMOIO4

## Author contribution

The contribution of each of the authors was as follows: Felipa Pinedo, carried out the field activities and wrote the manuscript, Juan M. Pérez, support in revising the manuscript, Manuel Gastelo, statistical analysis and support in writing the manuscript, and Ronal Otiniano, supervision of field work, wrote and revised the manuscript.

## References

1. World Health Organization. *Adolescent health and development: a WHO regional framework 2001-2004*. Appreciate that teenagers invest in the future. Philippines: WHO; 2015.
2. Bouis HE, Saltzman A. Improving nutrition through biofortification: A review of evidence from HarvestPlus, 2003 through 2016. *Glob Food Sec*. 2017;12:49–58.
3. ENDES *Demographic and health survey, national and departmental*. ENDES. Lima – Peru. 2021.
4. Zavaleta N. Childhood anemia: challenges and opportunities for 2021. *Rev Peru Med Exp Salud Publica*. 2017;34(4):588–589.
5. Chhetri K, Mynak ML, Pedon K. Anemia and risk factors among children 6 months to 59 months old: a hospital-based prospective study. *Bhutan Health Journal*. 2017;3(2):1–5.
6. Pereira FSM. Influence of iron deficiency on the practice of aerobic exercise by athletes and athletes: a review of the literature. *IJN*. 2018;11:467.
7. World Health Organization. *Hemoglobin concentrations for the diagnosis of anemia and assessment of severity*. 2011.
8. World Health Organization (WHO). *World Malaria Report*. 2018. p. 1–210.
9. Castro BJI, Maritza C Peinado D. Prevalence of childhood anemia and its association with socioeconomic and productive factors in a high Andean community in Peru. *Rev Esp Nutr Comunitaria*. 2019;25(3):1–11.
10. Paredes RP. Effect of environmental and socioeconomic factors of the home on chronic malnutrition of children under 5 years of age in Peru. *Journal of High Andean Research*. 2020;22(3):226–237.
11. Huaman LE, Juan PA, Eloisa NR, et al. Consumption of Chispitas® multimicronutrient supplements and anemia in children from 6 to 35 months: Cross-sectional study in the context of a population intervention in Apurímac, Peru. *Rev Peruana Med Exp Salud Publica*. 2012;29(3):314–323.
12. Vargas Vásquez A, Bado R, Alcázar L, et alEffect of a lipid-based nutritional supplement on hemoglobin levels and anthropometric indicators in children from five districts of Huánuco, Peru. *Peruvian journal of experimental medicine and public health*. 2015;32(2):237–244.
13. Ems T, St Lucia K, Huecker MR. *Biochemistry, Iron Absorption*. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing. 2024.
14. Lupaca Y. *Comparison of the effect of supplementation with multi micronutrients and the dietary proposal based on Beef blood on hemoglobin levels in boys and girls from 8 to 36 months of age at the José Antonio Envinas health center, Puno*. Thesis to qualify for the degree of: Bachelor of Human Nutrition, National University of the Altiplano Puno, Peru. 2018
15. Lizárraga E. Effect of a nutritional bar enriched with heme iron on hemoglobin levels in children aged 4-10 years. *Journal of Innovation and Productive Transfer*. 2021;2(2).
16. Vijayakumar TM, Ananthathandavan P, Ahalya SP, et al. Effect of Hemocare Syrup and Hemocare XT Tablets on Hemoglobin levels in iron deficiency anemia among women of reproductive age: A randomized, placebo controlled, open label trial. *Contemp Clin Trials Commun*. 2019;15:100425.
17. Kumar A, Mohanty V, Yashaswini P. Development of high protein nutrition Bar enriched with Spirulina plantensis for Undernourished children. *Curr Res Nutr Food Sci*. 2018;6(3).
18. Roses C. *Acceptability and iron content in Sangrecita chocochips bars with Sesame seeds (Sesamum indicum L.) and Flaxseed (Linum Usitatissimum)*. Thesis to qualify for the academic degree of master in food sciences. José Faustino Sánchez Carrión National University, Huacho, Peru. 2019.
19. Gastelo M, Otiniano R, Pinedo F, et al. *Dataset for: Effect of a nutritional bar "NUTRIBARRA ANDINA" in the control of anemia in children under 5 years of age in Chugay and Curgos*. 2012.
20. INS. *Procedure for the determination of hemoglobin, using a portable hemoglobinometer*. Technical Guide No 01/2012-CENAN-INS. Lima, Peru. 2012.
21. Neufeld L, García Guerra A, Sánchez France D, et al. Hemoglobin measured by Hemocue and a reference method in venous and capillary blood: a validation study. *Salud Publica Mex*. 2012;44(3):219–227.
22. Jordan T. *Technical Guide: procedure for determining hemoglobin using a portable hemoglobinometer*. Prepared by Teresa Jordán Lechuga. Lima: Ministry of Health, National Institute of Health. 2013. 41 p.
23. Centers for Disease Control (CDC). CDC criteria for anemia in children and childbearing-aged women. *MMWR Morb Mortal Wkly Rep*. 198938(22):400–404.
24. Hurtado A, Merino C, Febres ED. Influence of anoxemia on the hemopoietic activity. *An Fac Med Lima.* 1946;29(2):125–209.
25. Bono Cabré R. *Quasi-experimental and longitudinal designs*. Spain: University of Barcelona. Faculty of Psychology. Department of Methodology of Behavioral Sciences. 2012.
26. C.S. Reichardt, The statistical analysis of data from nonequivalent group designs. In: Cook TD, Campbell DT, editors. *Quasi-experimentation. Design and analysis issues for field settings*. Chicago, IL: Rand McNally. 1979.
27. World Health Organization. *Assessing Iron Status in Populations: Report of a Joint Technical Consultation with the Centers for Disease Control and Prevention on Assessing Iron Status at the Population Level*. 2007.