Effectiveness of mussels (*Mytella falcata*) in malnourished children's recovery living in the slums in Maceió, Alagoas

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Abstract

Objectives: to assess the efficacy of mussels (Mytella falcata) in malnourished children's recovery.

Methods: 64 chronically malnourished children were accompanied for 12 months and attended at the Centro Recuperação e Educação Nutricional (Recovery Center and Educational Nutrition). The children were paired by age and malnutrition level forming three groups, which they received a balanced diet for nutritional recovery differing only on protein source. The group was offered (1) preparation of red meat, group (2) preparation of mussels and group (3) preparation of mussels in coconut milk.

Results: the anthropometric assessment revealed that the children obtained a mean increase in the Z score in A-I indice of 0.70 for the group who red meat, 0.62 for the group who had mussels and 0.57 the group who had mussels cooked in coconut milk ($p<0,05$). An observation was made on a reduction in the prevalence of anemia with 22,8% ($p=0,002$), 27.8% ($p=0.,007$) and 42.4% (p 0.001) in groups 1, 2 and 3, respectively.

Conclusion: the preparation of mussels cooked in or not in coconut milk can be an effective substitution for meat in combating child malnutrition and anemia and may be included in the children's institutions menus and in the programs that aim for children's nutritional recovery.

Key words *Anemia, Growth, Children, Malnutrition, Mussels, Coconut Milk*

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Introduction

Childhood malnutrition, consisted of height deficit, is still a public health problem, especially when it is associated to anemia.[1,2] Among children under 5 years old, the anemia-malnutrition binomial is responsible for serious implications on growth and development.[3]

Besides these implications, malnutrition is associated to the increase of infant morbidity and mortality.[4,5]

Although the prevalence of protein-energy malnutrition (PEM) has decreased in Brazil[2] and especially in the Northeast,[6] due to social differences, it has been observed that, this severity still remains relevant, especially in some areas of poverty located in the outskirts of large cities.[6-10]

In order to contribute to the reduction of malnutrition rates, the program *Centros de Recuperação e Educação Nutricional* (CREN) (Recovery Centers and Educational Nutrition), a non-profit organization that was created in São Paulo and since 1993 is combating and preventing malnutrition in children and adolescents. CREN conducts an active search on malnutrition cases in the communities and counts on integrated actions that appreciate successful local initiatives, respecting regional cultures and above all, each person, family and the community.[11]

CREN is located in the 7th administrative region in Maceió City in Alagoas State with the lowest indice of human development in the city, which has 24 slum areas, where the prevalence of chronic malnutrition in children is approximately 10%, reaching 30% in extreme cases.[9,10] At CREN, children receive continued educational assistance, healthcare, infection control and five daily balanced meals with low-cost, high-nutritional regional foods.[8,11]

Brazil is characterized by great cultural differences among its states and territories reflect on food diversity. In Alagoas State the mollusk called mussels (*Mytella falcata*) cooked in coconut milk constitutes as a widely known and appreciated food preparation, its consumption is linked to its own culture. The mussels have a great economic, social and nutritional importance. The composition of the mussels of 100g prepared in coconut milk represents: 12.0 g of proteins, 7.1 g of lipids, of which 44.5% are represented by lauric acid, 4.7 g of carbohydrates and 3.1 g of ash.[12] In the preparation of mussels alone (17.56 mg / kg) or mussels cooked in coconut milk (13.8 mg / kg), the iron level also presents to be superior than red meat. The chemical form of iron found in mollusks is similar to that found in red meat products and the Heme has high metabolic bioavailability and chemical characteristics.[13]

However, there is no data in the literature about the presence of these foods in the local children's menu.

On the other hand, the coconut (*Cocos nucifera*) is a very widespread product in the Northeast of Brazil, mainly in Alagoas State and it, is rich in medium chain triglycerides (MCT) and its extract is widely used by food industries and it is well accepted in household dietary use.[14]

This present study had as an objective to evaluate the efficacy of the mussels cooked or not cooked in coconut milk in comparsion to red meat in malnourished children's recovery attended at the *Centro de Recuperação e Educação Nutricional de Maceió* (Educational Nutrition and Recovery Center in Maceió).

Methods

A longitudinal, experimental study with moderate to severe semi-internal malnourished children at CREN/Maceió. The research was conducted during a period of 12 months from September 2010 to August 2011 with three study groups. All the children received a balanced diet for nutritional recovery differed only in the supply of protein source. Group 1 was offered (red meat) preparation of red meat, group 2 (mussels not cooked in coconut milk - MNCCM) preparation of mussels not cooked in coconut milk and group 3 (mussesls cooked in coconut milk - MCCM) preparation of mussels cooked in coconut milk.

The groups were formed by 21, 22 and 21 children respectively, totalizing 64 participants ages varying between 12 and 71 months. The data on body weight, height, sex, age and eating habits were collected by nutritionists at the Center. For anemia diagnosis, a complete blood count was performed to analyze the hemoglobin values at the beginning and at the end of the study.

A selection criterion was defined as for all the children in the study had to be semi-internal at CREN. In this Center, the semi-internal children spend most of the day (Monday to Friday from 8:00 a.m. to 5:00 p.m.) having their intake controlled. During this research, at the time they were in their homes, the family members were told how much to offer the children and every Monday the families were interviewed so they could report what were the intakes. At home, the parent and/or legal guardian responsible for the child or children were instructed

to offer food that was part of the regular dietary habits of the families: rice, beans, cassava flour, bread, margarine and eggs. The only restriction was the consumption of red meat and viscera. These instructions were decided by the project team in a meeting prior to the beginning of the project and reinforcements were made in weekly meetings for the data collection of the feeding day habit of the weekend. Patients with any type of pathology that could interfere with the normal growth and development process were excluded from the sample. The children were assessed by a multidisciplinary team for health diagnosis before the beginning of the intervention, monthly and at the end of the study.

The selected children were paired by age and malnutrition level forming 3 groups, who remained from 8:00 am to 5:00 p.m. Monday to Friday at the Center, where they received a balanced meal with 90-100 kcal/kg/day and 3g/kg/day of protein and at the end of the afternoon they could go back to their homes.

The children received five meals/day. At lunch the groups were offered the study food in 30g of red meat portion for group 1 (meat); 60g of mussels for group 2 (MNCCM) and 60g for group 3 (MCCM). At dinner the groups were offered the same preparation of chicken or fish. It is important to point out that the difference in the proportion of red meat offered versus mussels are due to the protein quantity of the product, that's is. 30g of red meat and 60g of mussels have the same amount of protein. It is noteworthy that during the whole period of the experiment, the children of the groups that received mussels did not eat red meat. At CREN, the standard menu offered was composed of rice, beans, garnish, protein portion, fruit, vegetables, roots, bread, milk and eggs.

For malnutrition diagnosis and classification, the measurement of length or the indice of height for age (A/I), was used, it is according to the age group and sex. To measure the length of the children under 2 years of age, an infantometer equipped with an inextensible measuring tape of 105 cm in length and 0.1 cm in precision was used; to measure the height of those older than 2 years, a stadiometer with an inextensible metric tape measuring 2 m in length and 0.1 cm in precision was used. The procedures adopted for weight and height measurements were homogeneous and according to as recommended by Frisancho.[15]

The referred standard to assess the nutritional status of the children was from WHO.[16] Based on the data, the A/I indice was composed by using the Anthro version 2007. For those over 60 months old, WHO[17] published table was used.and the formula was applied to obtain the standard deviation (SD) of these children's indice. The diagnosis of normality was attributed to the children between +2 and -2 SD. The determination of moderate malnutrition was defined by the cut-off point score of $Z< -2$ and the severe malnutrition was by the cut-off point score of $Z\leq -3$ for the A/I indice.

The children's dietary pattern was assessed through the food offered at CREN. For this reason, the children's average weekly intake in each group was calculated by the use of the AVANUTRI® program. The service recommendation of macro and micronutrients was observed.[17,18] (Table 1)

To perform laboratorial tests, blood samples were collected at CREN between June and July 2010 with all the children in the study and repeated at the end of the study in September 2011. Samples of 10 ml of blood was obtained in children in fasting for 12 hours and immediately taken for biochemical measurements at an authorized clinical laboratory .

The hemogram was performed with the objective of detecting iron deficiency anemia. The classification used for anemia diagnosis was the one recommended by WHO[3]: iron deficiency children up

Table 1

Diet offered to children attended in a semi-internal program at CREN/AL - 2009-2010.

Nutrients	Red Meat	MNCCM	MCCM
TCV (Kcal/Kg d)	100.7	100.3	103.3
Protein (g/Kg d)/	3.5	3.7	3.5
Carbohydrate (%)	59.2	59.4	58.4
Lipid (%)	27.7	25.9	27.7
Zinc (mg)	4.0	3.0	3.1
Vitamin A (RE)	344.0	344.2	335.5
Iron (mg)	4.3	4.8	4.3

TCV = Total Caloric Value; MNCCM = Mussels not cooked in coconut milk; MCCM = Mussels cooked in coconut milk.

to 5 years of age with hemoglobin levels <11g / dL, and children aged 5 to 6 years old with hemoglobin <11.5g / dL. It should be noted that the children diagnosed with anemia were treated before the study began in September 2010.

The children who did not remain during the 12 months study were considered "loss", (mainly due to the family moving away and not informing the new address). Of these "loss" 2 children were in group 1 (red meat), 4 in group 2 (MNCCM) and 2 in group 3 (MCCM). Of the 64 children initially selected, 56 were included in the final judgment of food interventions.

In the statistical analysis, the variables met the normality assumptions (Lilliefors test) and the homogeneity of the residual variances (Levene test). The means comparison of the continuous variables among the groups were performed by ANOVA with the Tukey-HSD *post-hoc* test. The categorical variables were compared by using the chi-square test. A 5% probability value was adopted for null hypothesis rejection.

The project was approved by the Ethics Committee Research at the Universidade Federal de Alagoas, under the number 9580 / 2007-26 and complied with the Resolution number 196 on 10/10/1996 at the *Conselho Nacional de Saúde* (National Health Council). All the parents and/or legal guardians responsible for the child or children signed an Informed Consent Form before being included in the sample.

Results

Of the 64 children studied, 50 were moderately malnourished and 14 were severely malnourished and had a mean age of 41.2 ± 15.8 months. The general characteristics of the participants in each group (Table 2) show that in the pre-intervention period of the A/I indice and the percentage of anemia did not differ between the 3 groups demonstrating their homogeneity before the nutritional intervention.

The anthropometric assessment at the end of the study revealed that the children had a mean increase in Z score at the A/I indice of 0.70 for the red meat group, 0.62 for the MNCCM group and 0.57 for the MCCM group, no statistical differences were observed among the groups (Table 3).

When the initial and final A/I mean intragroups were observed, when the values were compared at the beginning and after 12 months of intervention, the results showed statistically significant height evolution in all the groups.

The hemogram results showed a reduction in the anemia prevalence in all the groups studied when comparing the initial values to the final values, resulting in a reduction of 22.8% (p=0.002), 27.8% (p=0.007) and 42.4% (p=0.001) in the red meat, the MNCCM and the MCCM groups respectively. However, there was no statistical difference among the groups (Table 4).

Table 2

General characteristics of the groups in the pre-intervention period regarding stature deficit and anemia prevalence in children attended in a semi-internal regime at CREN/AL - 2009.

Characteristics	Red Meat (n=21)		MNCCM (n=22)		MCCM (n=21)		*p**
	n	%	n	%	n	%	
Stature *deficit*							0.15
Moderate	16	76.19	20	90.91	14	66.67	
Severe	5	23.81	2	9.09	7	33.33	
Anemia	7	33.33	11	50.00	10	47.62	0.49
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	***p****
Age (months)	40.81	16.28	41.54	15.47	41.19	16.36	0.98
A/I Indice	-2.75	0.52	-2.66	0.52	-2.78	0.59	0.77
Hb (mg/dL)	11.14	1.27	10.,98	1.09	11.36	1.17	0.57

MNCCM = Mussels not cooked in coconut milk; MCCM = Mussels cooked in coconut milk; *p** chi-square test; *p*** one factor ANOVA.

Table 3

Variation of the height-for-age indice after 12 months of intervention according to the children's nutritional status attended in a semi-internal regime at CREN/AL - 2009-2010.

Variables	Group						*p**
	Red Meat (n=19)		MNCCM (n=18)		MCCM (n=19)		
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	
Final A/I (Z)	-2.05	0.68	-2.06	0.54	-2.21	0.56	0.65
Increased	0.70	0.33	0.62	0.49	0.57	0.22	0.55

A/I: Height-age indice; MNCCM = Mussels not cooked in coconut milk; MCCM = Mussels cooked in coconut milk; *p** One factor ANOVA.

Table 4

The frequency of anemia and the mean of hemoglobin concentration in the groups after 12 months of intervention in children attended in a semi-internal regime at CREN/AL - 2009-2010.

Variables	Group						*p*
	Red Meat (n=19)		MNCCM (n=18)		MCCM (n=19)		
HB (mg/dL)*	12.07	0.67	12.06	0.75	12.03	0.70	0.98
Anemia**	2	10.5	4	22.2	1	5.6	0.30

MNCCM = Mussels not cooked in coconut milk; MCCM = Mussels cooked in coconut milk; *Data presented as mean and standard deviation. Variable submitted to one factor ANOVA; ** Data presented as absolute and relative frequencies. Variable submitted to the chi-square test.

Discussion

In this present study it is evident that the nutritional treatment offered to children at CREN was effective in improving their nutritional status regardless of the type of protein used (red meat or mussels). In this sense, it is known that effective interventions to recover nutritional status are a necessity since growth retardation and anemia are serious public health problems that interfere in the long-term development.[19-21] When energy and nutrient consumption is below the needs, this inadequacy interferes in the child's growth process, so this determinant factor appearing in several clinical manifestations will repercute in the adult life.[8]

A study conducted by Grillenberger *et al*.[20] with schoolchildren in the rural area in Kenya showed that the daily inclusion of 200mL of milk or 60mg of red meat in the children's diet was associated to the improvment of their nutritional status and growth. According to the authors, this result is due to the elevated quantity of bioavailable amino acids in the food.

In a study[21] in Cambodia, children between 12 and 59 months of age was shown that the consumption of a varied diet was associated to reducing dwarfism. The study examined food consumption in the last 24 hours prior to the research. Food were grouped into 7 groups according to WHO and among the food groups assessed, the lowest risk of short stature was associated to the group that had food intake of animal origin.

Another study carried out in São Paulo state with malnourished children participating in an interdisciplinary program that offered a liter of milk/day for approximately one year, there was a 22.6% reduction in the prevalence of chronic malnutrition.[22] This result is lower than the one found in the present study which observed a reduction of the stature deficit in 46.4% of the children after the intervention period. In this present study, the positive impact on stature recovery was noticable among all the groups with a mean Z score increased of 0.65 in the A/I indice.

The high prevalence of anemia found at the beginning of this study (43.6%) was similar to the one found among children in the same age group in a city day care centers in other Brazilian States, such as in Rio de Janeiro (41.9%)[23] and among children

from 6 to 59 months in Pernambuco State.[24] In relation to the percentage of children that at the end of the intervention did not present anemia (31%) this was higher than what was observed in a study in a day care center in Rio de Janeiro (14.5%), in which they used rice fortified with iron[23]; and in a study carried out in Manaus, in the Amazonas State (14%), the children consumed cassava flour fortified with iron.[25]

Our results point out to the positive effect of the use of mussels to reduce anemia on a higher scale than fortified food. This could be explained by the fact that the MCCM contains iron of greater bioavailability.

In another study[19] carried out in Kenya, children with iron deficiency anemia, there was an urgent need to increase the consumption of animal protein in their diet as a strategy to prevent and control anemia. Therefore, this present study revealed that the food consumption of animal origin such as meat and mussels preparation contribute to the recovery of the nutritional status of malnourished children, particularly in reducing stature deficit and anemia prevalence.

According to the present results, the preparation of mussels cooked in or not in coconut milk can be an effective substitute for red meat in the fight against child malnutrition and anemia, since the children who received these preparations had an increase and growth evolution similar to the group of children who consumed meat.

Associated to height gain, it was possible to observe the decrease of anemia in all the groups, concluding that the preparation of mussels cooked in or not in coconut milk is rich in iron and can be included in the chronically and anemic malnourished children's diet as part of the nutritional deficiencies treatment.

For this reason, we suggest that these regional preparations can be included in the children's institutions menus (kindergarten, school) and programs aimed for the children's nutritional recovery.

Among the limitations of this study was the reduced sample size, and therefore, the present results should be taken in consideration and with care and new works should be carried out to continue the importance of this subject to these populations.

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