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RESEARCH ARTICLE

MUCUNA PRURIENS (DOLICHOS PRURIENS) AS NUTRITIONAL SUPPLEMENT AND COGNITIVE ENHANCER IN CHILDREN

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ABSTRACT

Mucunapruriens (MP) has been used in the Indian system of traditional medicine (Ayurveda). MP has been proposed as a cognitive enhancer and nutritional supplement due to the high nutritional value and low cost. The object of this study was to access nutritional supplement (NS) and cognitive enhancement (CE) qualities of MP in a group of school children aged 6-9 years from marginal urban area of the City of Guayaquil, Ecuador. The universe consisted of 51, school children 6-9 years old, out of a total school population of 120 students. A pediatric assessment was performed at the school through medical history, anthropometric measurements, and auscultation of vital organs. Blood count, glucose, total protein physico-chemical urine tests were performed. Nutritional supplement studies were sustained for 6 weeks. After 6 weeks, analyzes were repeated by pediatric MD. The Bender-Koppitz Test was selected to measure the maturity level of visual-motor perception in the students. Prior to intervention, children manifested impulsive aggressive behavior and lacked the capacity to plan. After the intervention both attention and cognitive adjustment tended to improve in the population. MP supplementation proves as a potential candidate for both nutritional and cognitive supplementation.

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INTRODUCTION

The velvet bean plant: *Mucunapruriens (plural), also known as Dolichospruriens (singular)*is a leguminous plant, indigenous to the Indian subcontinent. The seed extract has been used in the Indian system of traditional medicine (Ayurveda), as an antiparkinsonagent. This property has been studied in several preclinical and clinical trials (Kasture *et al*., 2013; Adebowale *et al*., 2005; Katzenschlager *et al*., 2004; Manyam *et al*., 2004). Antiparkinsonian activity has mainly been attributed to the levels of L-Dopa present in the seeds (Kasture *et al*., 2013). Cognitive enhancers are drugs, supplements, nutraceuticals and functional foods that are purported to improve mental functions such as cognition, memory, intelligence, motivation, attention and concentration (Tabassum *et al*., 2012). Mucunapruriens (MP) has been used as human and animal nutritional supplement since ancient Aayurvedic tradition. MP has also been proposed as a cognitive enhancer (Tabassum *et al*., 2012; Pranav, 2013; Kala and Mohan, 2010; Prias and Painni, 2009).

MP supplements are of great interest due to the high nutritional value and low cost. The variety *Dolichospruriens L*. contains: raw crude protein 32.4 g%, fat 5.7 g%, crude fiber 7.8 g%, ash 3.6 g%, carbohydrates 50.6 g%[7,9], Na 2.87 g%, K 3.8 g%, Ca 262 g%, Mg 52.8 g%, P 457 g%,Fe 14.9 g%, Zn 3.76 g%, Mn 0.30 g%. Amino Acids (g%)[7]: Alanine63.9, Arginine 90.6, Asparagine and aspartic acid 171, Glycine 50.5, Histidine35.3, Isoleucine 92.3, Leucine 90.8, Lysine 46.4, Phenylalanine 80.8, Prolamin 151, Serin 41.5, Tryptophan 22.3, Tyrosine 70.9, Valine 58.3, traces of Cysteine, Methionine, Glutamine and

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Glutamic acid. Total essential amino acids 39.8 g%, in vitro protein digestibility of 84.6% (Prias and Painni, 2009; Siddhuraju *et al*., 1996).

The object of this study was to access nutritional supplement (NS) and cognitive enhancement (CE) qualities of bread and shake enriched with MP in a group of school children aged6-9 years from marginal urban area of the City of Guayaquil, Ecuador.

MATERIALS AND METHODS

The universe consisted of 51, school children 6-9 years old, out of a total school population of 120 students. Students attended the School # 729 "My Genesis2000¨, Sector Juan Montalvo, Precoorperativa Estrella de Belén, Guayaquil, Ecuador (Figure 1).

Figure 1. Location of the school with respect to Guayaquil, Ecuador

Sample consisted of 28 girls and 23 boys chosen at random, from 1st through 4thgrade of basic education whom usually attend the school system. School is located in a marginal urban area of the city of Guayaquil with limited economic and socio-cultural condition; disaggregated households; parents without academic career and mainly working in the informal market. For this study, seeds were collected from the experimental fields of the Agricultural Institute of Technology Vinces (ITAV) at the University of Guayaquil (Agricultural Research Program). ITAV is located at kilometer 1 ½ Vinces - Palestine way, geographical coordinates: 01º 34' South latitude and 75º 44' West longitude, at an altitude of 41mabove sea level, with an average annual temperature of 25.4 ºC, precipitation of 1400 mm of H_2O and relative humidity of 84%.

MP seeds where evaluated for nutritional value: Protein content, essential amino acids, fatty acid profile, lipo and hydro soluble vitamins and protein digestibility. Nutritional value was performed at the Quality Management Program (PROGECA) and Chemical Analysis Laboratory of the Faculty of Chemical Sciences at the U of Guayaquil. A typical Guayaquilean bread was developed and enriched with 15% by weight MP flour. Bread composition can be found in Table 1.The shake formula was developed by the author Leila Priasin the Chemical Analysis Laboratory. It was tested for palatability by applying sensory evaluations to groups consisting of mothers and children between 6 and 9 years of age. Formula for the shake is presented in Table 2. Flour was developed at the Unit Operations Laboratory and processed products (bread and shake) in the Gastronomy workshop, both at the Faculty of Chemical Engineering. The following process was utilized to prepare the flour: Grains were selected and cleaned; pre baked at 80 °C for 30 min and dried (80-90 °C). Coarse grinding was performed with a hammer mill and fine grinding with a Ball mill.

The flour was graded, approved and packed by Quality Control (OAE. AOAC 925.10, 2005; OPTTS, 1996; Pharmacopeial Convention, 2009; USP. USP29-NF24, 2006).

Teacher Survey

Prior to the study, informed consent was obtained from parents, teachers and school principal. About 65% of mothers and 10% of fathers, who understood the intention of the project, agreed to the test, noting that their children would benefit, and grateful to have been taken into account for this study. Each teacher (6 IN TOTAL) was given a survey that consisted of 8 questions, with 5 possible response options (NEVER, SOMETIMES, NOT KNOW/NO ANSWER, ALMOST ALWAYS, ALWAYS) related to the overall performance of their students:

1. Do children have learning difficulties?
2. Are you satisfied with the academic performance of the students?

3. Are the children asleep in class?
4. Do students eat breakfast? School at home daily?
5. Is there parental concern for the welfare of their children?
6. Do parents attend parent meetings called by the school?
7. When a child is depressed and/or has learning difficulties, do you communicate with the principal and/or representative?
8. Are Parents involved in school activities?

Table 1. Salt Bread containing MP flour

Ingredients	Amounts
Wheat flour	1,100 g
Water	500 g
MP Flour	400 g
Margarine	400 g
Salt	150 g
Eggs	8u

Table 2. Formula for shake containing MP flour

Ingredients	Amounts (%)
Water	61.5
Oatmeal	13.0
MP Flour	13.0
White granulated sugar	10.0
Mashed Naranjillas (Solanum Quitoense)	2.0
Cinnamon stick	0.5

Clinical Assessment

Before starting the intake of nutritional supplement, a pediatric assessment was performed at the school through personal interview (medical history), anthropometric measurements, and auscultation of vital organs. A review of clinical tests: blood count, glucose, total protein physical-chemical urine tests were performed. School children were accompanied by their respective representatives throughout the tests. After 1 week food nutritional supplement studies were initiated and sustained for 6 weeks. Supplementation was as follows: one Salt Bread (Approx. 36 g) and a pouring glass (250 ml) of shake during Playtime. After 6 weeks, analyzes were repeated by pediatric MD. Clinical analyzes were performed at the "José Darío Moral" Clinical Laboratory of the Faculty of Chemistry.

Psychological Assessment

The Bender-KoppitzTest (1938) was selected to measure the maturity level of visual-motor perception in the students; and to reveal possible dysfunctions. The Testcan be used as a personality test (emotional factors and attitudes) and as a test to probe children with learning disabilities.

The Bender-Koppitz test (1938) primarily measures visual-motor acuity, assessing two functions: visual memory and visual-motor coordination. The structure of the Test is to copy nine cards (10 x 15) with abstract drawings where visual-motor maturation indicators and Emotional Indicators are reflected. It is suitable for primary school children. It has been standardized for ages 5 years 0 months through 10 years 11 months. In this test there are 7 deviations or indicators that select between good or poor school performance and that relate to three basic functions of the visual-motor perception:

- Ability to perceive objects as a limited whole.
- Ability to perceive and copy correctly, in terms of orientation and shape.
- Ability to integrate the parts into a single Gestalt.

Materials: Nine design printed cards, devoid of significance (one design on each card), the first figure is the A and the others are numbered from 1 to 8. White letter size sheets. (it will normally occupy one or two sheets to copy all the designs).A lead pencil with eraser. Procedure: Schoolchildren were told in simple language the job they should attempt, trying to empathize with each of them. They were given each a piece of paper in a vertical position and were told the slogan: "Here I have nine drawings, I want you to copy them ... Here I go first, make one like this ... " the interviewer stood in front of the child with card A and drew an example. The cards are given one by one in sequence, with no time limit. There was no indication of where in the paper should the design be copied (if the child asks, the tester responds in the desired part not using ruler, protractor or any other additional material).The graphics developed by the child were evaluated taking into account deviations for 7 pre - established indicators:

1. Distortion of shape (eg disproportion)
2. Rotation (of the entire design or parts thereof)
3. Replacing points by circles.
4. Perseverance.
5. Lack of integration.
6. Omission of angles.
7. Replacing angles with curves.

From these deviations, one arrives at 30 items that constitute the scoring system. Each of the 30 items is assigned a point (if the deviation is present, and zero if it is not observed), therefore, the higher the score, the greater presence of deviations from the original designs. The scores for each child were compared with the patterns according to their chronological age, according to this assessment, visual-motor maturation was diagnosed as related to school performance. Testing time is highly significant “average” children need about 6 minutes 20 seconds, while children with learning and behavior disabilities tend to work faster (5 min. 19 sec.), Hyperactive children, only take 4 minutes 41 seconds (Kaplan, Robert and Saccuzzo, Dennis 2009).

RESULTS

Teacher Survey

The results from teacher survey (6 teachers in total, Table 3), show that 80% of students are inattentive during their class hours, i.e. the concentration is very limited. According to the criterion of teachers they show physical fatigue from the early hours of the morning, some are quiet and sleepy. The other 20% are not always attentive. 70% of the students have little participation in physical activity. Usually in the morning when they arrive at school no desire to practice sports and/or school games in general. 30% of students sometimes participate in these physical activities, situations that in both cases are not normal in children aged between 6-9 years of age. 66 % believe that parents "sometimes" worry, considering that this expression is also limited to inadequate nutrition.

Table 3. Results for questions on the survey of all teachers (T1 through T6) of the School # 729 "My Genesis 2000". Guayaquil, according to the Likert scale (NEVER, SOMETIMES, NOT KNOW/NO ANSWER, ALMOST ALWAYS, ALWAYS)

QUESTION	T1	T2	T3	T4	T5	T6	AVG
Do children have learning difficulties?	2	4	4	4	4	2	3.33
Are you satisfied with the academic performance of the students?	4	4	4	4	4	4	4.00
Are the children asleep in class?	5	5	5	5	5	5	5.00
Do students eat breakfast? School at home daily?	2	2	2	2	2	2	2.00
Is there parental concern for the welfare of their children?	1	2	1	2	1	2	1.50
Do parents attend parent meetings called by the school?	2	2	2	2	2	2	2.00
When a child is depressed and/or has learning difficulties, do you communicate with the principal and/or representative?	5	5	2	5	2	2	3.50
Are Parents involved in school activities?	2	2	2	2	2	2	2.00

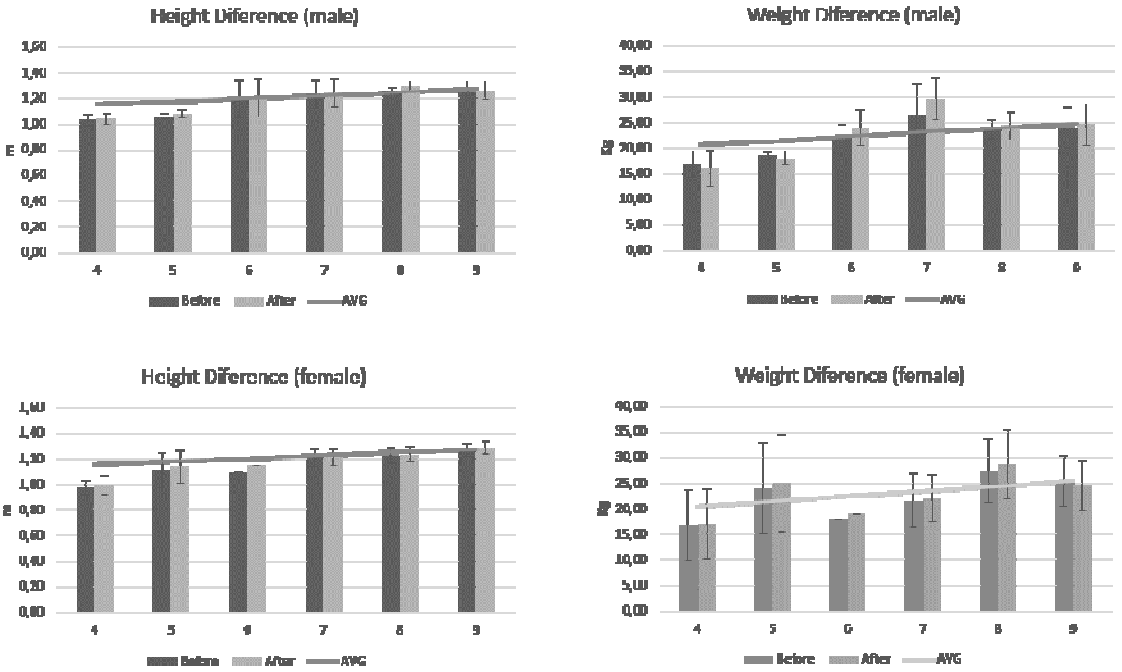

Figure 2. Anthropological Measures, height and weight of male and female students as compared to average height and weight of same age children from the city of Guayaquil

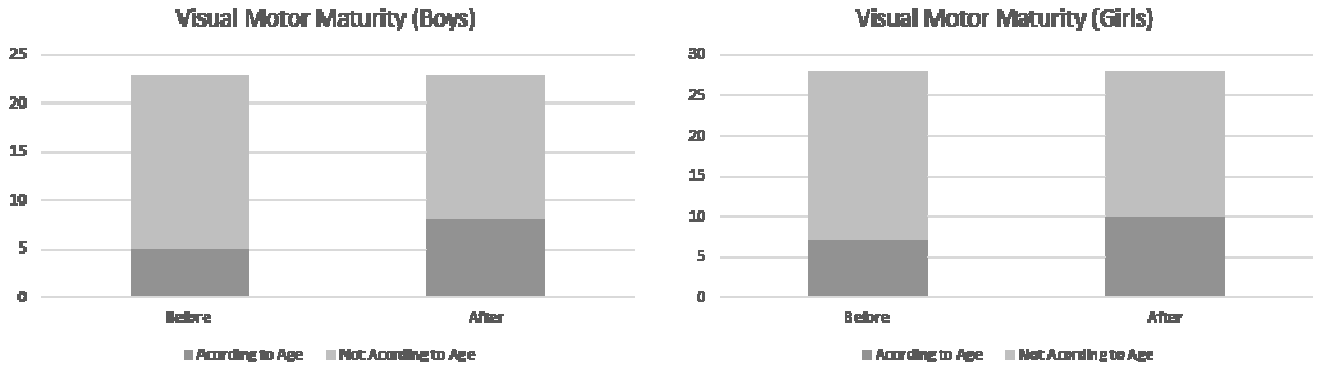

Figure 3. Bender-Koppitz visual-motor acuity results for boys and girls of the School # 729 "My Genesis 2000", from the City of Guayaquil

33 % of parents are "never" concerned about good nutrition for their children. 83.33% of the students "always" come to school without breakfast or with an incomplete breakfast, 16.67% "sometimes" eat breakfast. There is little interest from parents especially dads for activities that take place at school.

Clinical Assessment

Boys and girls were grouped by age for anthropological measures before and after supplementary treatment. Anthropological measures were compared to average size/weight ratios for children from a similar marginal urban

area of the city of Guayaquil (Gordillo and Silva, 2014). Anthropological Measures are presented in Figure 2.

Psychological Assessment

Interpretations to the Bender-Koppitz test (Bender, 1938), should provide a measure of both, visual-motor maturity and emotional adjustment. Results for visual-motor acuity are presented in Figure 3.

Emotional adjustment is measured according to ten domains. Results are presented in a perceptual basis to emphasize the relative outcome of the test. Reduction in emotional distress can be seen for all of the domains.

Of particular significance are domains 2, 3, 8 and 10 from Figure 4. Interpretation of these domains are as follows:

- Second attempt implies children who are impulsive and lack internal control needed to clear and carefully correct the wrong part. It also occurs in anxious children who associate particular meanings to the drawings.
- Review of Drawing or Stokes imply Impulsivity, aggression and behavioral "acting out".
- Stripes instead of circles imply impulsiveness, lack of interest or attention.
- Confused Order suggests lack of capacity to plan, order the material. Mental confusion.

"The intelligence quotient (IQ), for children was measured according to the Wechsler Preschool and Primary Scale of Intelligence (WPPSI) (Wechsler, 1989). IQ results can be seen in Figure 5.

DISCUSSION

According to the teacher surveys (Table 3), all teachers responded that children have difficulty to assimilate learning. Students are unable to retain the knowledge, nor strengthen their visual-motor skills. They do not have the capacity to acquire skills and abilities for their age, impairing their intellectual development. The carelessness of parents regarding their children's nutrition either by ignorance of the importance of good nutrition or because they simply do not care is alarming. In order to supplement nutrition and provide additional cognitive enhancement, the MP supplementation was investigated. After 6 weeks of supplementation both nutritional and cognitive levels increased. The mean height of children tended to increase in relation to comparative growth for children from the same age group. In the case of boys, visual motor maturity increased from 21,74% to 34,78%, and from 25,00% to 35,71% in the case of the girls. This means that measured maturity corresponded to chronologic age of the children in more cases than before (Figure 4). According to the ranges of Intelligence Quotient (IQ), before the intake of MP nutritional supplement, the range of girls was 83.57 and 80.70 for boys corresponding to "Slow Normal Intelligence", after the ingestion of MP based nutritional supplement, the range of girls

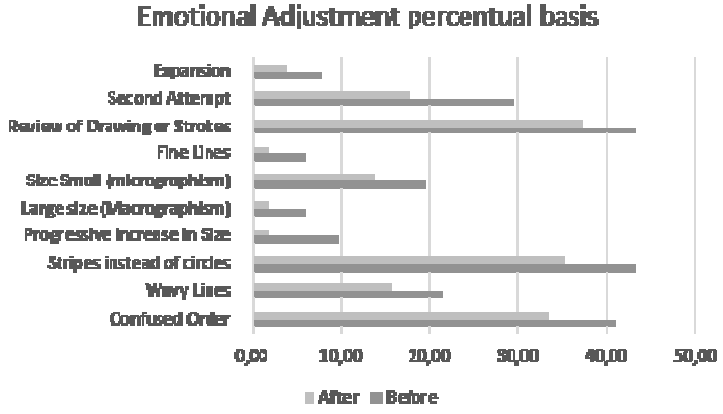

Figure 4. Bender-Koppitz Emotional adjustment results for the whole sample of the School # 729 "My Genesis 2000", from the City of Guayaquil. Presented as a percent basis

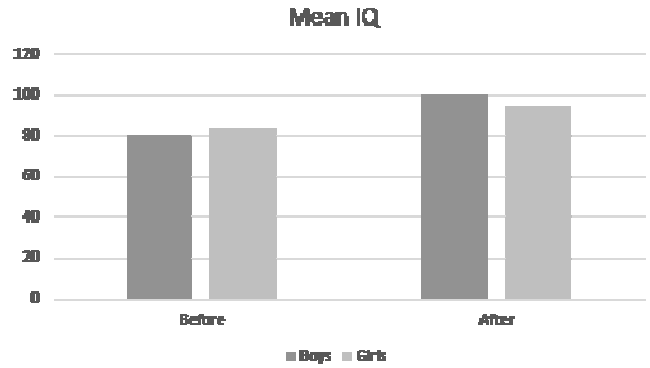

Figure 5. Mean intelligence quotient (IQ) for boys and girls of the School # 729 "My Genesis 2000", from the City of Guayaquil, according to the Wechsler Preschool and Primary Scale of Intelligence (WPPSI)

was 93.96 and 100.30 for boys corresponding to "Normal Average Intelligence", a phenomenon which coincides, with the Flynn Effect (Flynn, 1987) in which specialists say that better nutrition, better development of visual-motor maturity. Taken together prior evaluations suggest that before the test children manifested impulsive aggressive behavior and lacked the capacity to plan. This is consistent with the results from teacher interviews (Table 3). After the intervention both attention and cognitive adjustment tended to improve in the population.

Conclusion

The economic, social and cultural status of the parents from Sector Juan Montalvo, Precoorperativa Estrella de Belén, Guayaquil, Ecuador, does not guarantee an effective environment for the development of children. That is the development and / or strengthening of visual-motor skills is directly related to nutrition at an early age and has direct effects on indicators of human development. The bio-psycho-social development of students, requires emotional, cultural, cognitive, social, intellectual environment, A complex system of skills and abilities that society demands. Nutritional supplementation is obligatory if students are to develop fully and have a chance to compete in the cognitive domain. However food supplementation is not enough if children are to recover from attention disorders and improve their IQ development. MP supplementation proves as a potential candidate for both nutritional and cognitive supplementation. Long term evolution has to be tested in a larger group but the previous results suggest cognitive supplementation is possible and produces short term results.

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