IV REUNIÃO DE BIOFORTIFICAÇÃO
Teresina - Piauí - Brasil - 2011

THE IMPACT OF QUALITY PROTEIN MAIZE (QPM) ON SCHOOL CHILDREN'S WEIGHT AND HEIGHT: RESULTS FROM AN EFFECTIVENESS TRIAL IN COLOMBIA

Helena Pachón[(1)], Sayda Milena Pico Fonseca[(1)] and Jorge Gómez Jiménez[(2)]

[(1)]Centro Internacional de Agricultura Tropical (CIAT), h.pachon@cgiar.org, saydamile@hotmail.com;
[(2)]Independent Consultant, jorge_gomez_cu@yahoo.es

Keywords: Nutrition, child growth, maize, biofortification, amino acids

Introduction

Biofortification is the process of increasing the nutrient concentration of staple crops[1]. One of the first biofortified crops was quality protein maize (QPM). Due to a naturally occurring mutation, QPM has a greater concentration than common maize (CM) of lysine and tryptophan, two of the limiting amino acids in cereals[2]. Compared with CM, QPM, or its predecessor, opaque-2 maize, improves by 10% the weight and height of mildly to moderately malnourished preschool children[3]. QPM or opaque-2 maize also improves nutritional outcomes in severely malnourished children, or those recuperating from severe malnutrition[4-6]. The nutritional impact of QPM in school-age children has never been studied. The objective of this study was to evaluate the impact on school children's weight and height of consuming QPM through a government-supported school-feeding program.

Methods

Ethical approval was received from the Universidad de Antioquia in Colombia. A multi-stage process was followed to identify schools and children to participate in the study from a rural, predominantly indigenous municipality in southwestern Colombia. Twenty seven of the 84 schools in the municipality were invited to participate based on proximity to the highway and participation in the government's school-feeding program; 13 accepted. Informed consent forms were sent to the parents of all children in kindergarten through 3rd grade (n=1085); 453 were signed. In a screening phase, 409 of these children were measured for weight, height and hemoglobin. Based on the results, 314 children from 12 schools were selected for inclusion in the study because they were between 4 and 10 y, attended kindergarten through 3rd grade, and did not attend a school located at more than 2000 masl, where the study maize could not be grown.

Intervention - There were three intervention groups; the intervention was at the school level. In a quasi-experimental design, schools were assigned to receive QPM seed (SEED) for planting (n=4), QPM for consuming (n=3), or CM for consuming (n=5). Selection into the SEED group was by convenience; these schools were beneficiaries of two government feeding programs. Among the remaining 8 schools, assignation into the QPM or CM consumption groups was random; these schools were beneficiaries of one government program. In the consumption schools, all children in the school received the assigned maize during the school-feeding program. Only a subset of these children were measured at baseline and endline.

QPM and CM groups received sufficient maize for all children in the school to consume 35 g/school d. The SEED group received 3 kg of QPM seed to produce ~600 kg of maize. Distribution of maize for consumption began in September 2009. The intervention was slated for 9 mo; however, civil strife prevented monitoring between March and August 2010 and delayed endline data collection until August-September 2010. Therefore, the consumption groups received maize for 12 mo. The SEED group received seed in September 2009; insufficient water due to a prolonged dry season in 2009 resulted in crop failure for 3 of the 4 SEED schools. The fourth school harvested 90.9 kg in 2010; it was distributed to the school feeding program (22.7 kg), 11 families (62.5 kg), and a farmer (5.7 kg as seed).

During the school-vacation period (November 2009-February 2010), maize was provided to the consumption groups. Specifically, 35 g maize/family member/d were provided to children in the QPM and CM groups, sufficient for all family members. Based on self-report, 71% and 54% of QPM and CM families, respectively, who received maize during the vacation period served it to the children.

Measurements – Enumerators, blind to the schools' intervention group, measured children's weight to the nearest 0.1 kg and height to the nearest 0.1 cm at baseline (n=310) and endline (n=274). Thirty six children were not measured at endline for these reasons: moved (n=34), did not attend school on measurement day (n=2). Four children changed schools during the intervention period. Z scores were calculated using WHO AnthroPlus[7]. At baseline, children's parents were surveyed about sociodemographics, food security, diet and other characteristics. Milled maize, as provided to the schools and families, was periodically analyzed for tryptophan, which is highly correlated with lysine concentration[8]. At the schools, the amount of maize-containing foods served to and consumed by children was measured near baseline and endline.

Results

At baseline, there were differences among the intervention groups in child gender, age, indigenous or not, school grade and height ($P \leq 0.05$). The groups were similar with respect to child weight, having consumed animal-source foods in the past 7 d, appetite in the past mo, household socioeconomic strata, the relationship between number who work and number who live in the household, number of household assets, household food security, and the time needed to travel to the closest health unit ($P > 0.05$). At baseline, 33.7% of the children were stunted (height-for-age Z <-2).

Table 1. Children's weights and heights at baseline, endline and the difference between these time points, stratified by intervention group.

Intervention Group (n)	Weight (kg)			Height (cm)		
	Baseline	**Endline**	**Difference**	**Baseline**	**Endline**	**Difference**
SEED (n=119)	21.5	23.7	2.2[a]	112.1	118.2	6.0[a]
CM (n=75)	22.1	24.9	2.8[a]	115.7	121.6	5.8[a]
QPM (n=80)	21.7	24.3	2.6[a]	115.8	121.9	6.1[a]

Different letters in the difference column signal statistically significant differences ($P \leq 0.05$).

Children gained 2-3 kg and 6 cm during the study, regardless of the intervention group (Table). Using an intention-to-treat analysis, these results did not change after adjusting for the cluster design and covariates. Mean ± SD tryptophan levels were 28% higher in milled QPM (0.066 ± 0.012%) than milled CM (0.052 ± 0.009%). During the intervention (174-192 d), schools provided maize 38-166 d. Maize consumed by children ranged from 16 to 110 g/d.

Discussion

The three intervention groups had similar weight and height gains. Several questions were explored to identify the reason(s) for these findings. *Did the children have the potential to respond to the intervention?* Yes, 33.7% had low height-for-age at baseline and children grew ~3 kg and 6 cm during this period. *Was the intervention delivered daily to the children?* No, schools provided maize 21-89% of the academic year. *Was the intervention delivered differentially based on intervention group?* Yes, CM schools served maize on average 13.6 d more than QPM schools. *Did children consume 35 g/d of maize at school?* No, they consumed between 16-110 g/d. *Was the quantity of maize consumed different based on intervention group?* Yes, CM schools served ~3 times more maize than QPM schools. *Was there more tryptophan in the QPM than CM?* Yes, 28% more. *Was this difference observed in previous studies that obtained nutritional impact of QPM?* No, ≥42% differences in tryptophan concentration between CM and QPM were observed in other studies[5,9-11].

Conclusion

Under real-life conditions, QPM did not improve school children’s nutritional status. This could be due to the intervention not being delivered as planned in a school-feeding program, with respect to the amino acid concentration in the maize, the number of days it was served to children, and the quantity offered.

Funding

AgroSalud (CIDA 7034161).

References

[1] Nestel P, Bouis HE, Meenakshi JV, Pfeiffer W. Biofortification of staple food crops. J Nutr 2006;136:1064–7.

[2] Mertz ET, Bates LS, Nelson OE. Mutant gene that changes protein composition and increases lysine content of maize endosperm. Science 1964;145:279-80.

[3] Gunaratna NS, De Groote H, Nestel P, Pixley KV, McCabe GP. A meta-analysis of community based studies on quality protein maize. Food Policy 2010;35(3):202-10.

[4] Reddy V, Gupta CP. Treatment of kwashiorkor with opaque-2 maize. Am J Clin Nutr 1974;27:122-4.

[5] Graham GG, Lembcke J, Lancho E, Morales E. Quality protein maize: Digestibility and utilization by recovering malnourished infants. Pediatrics 1989;83:416-21.

[6] Graham GG, Lembcke J, Morales E. Quality-protein maize as the sole source of dietary protein and fat for rapidly growing young children. Pediatrics 1990;85:85-91.

[7] WHO. AnthroPlus, version 1.0.3. http://www.who.int/growthref/tools/en/

[8] Vivek BS, Krivanek AF, Palacios-Rojas N, Twumasi-Afriyie S, Diallo AO. Breeding Quality Protein Maize (QPM): Protocols for developing QPM cultivars. Mexico: CIMMYT, 2008.

http://libcatalog.cimmyt.org/download/cim/90320.PDF

[9] Ortega EC, Coulson AJ, Ordóñez LI, Pachón H. Efectos de la ingesta de maíz de alta calidad de proteína (QPM) versus maíz convencional en el crecimiento y la morbilidad de niños nicaragüenses desnutridos de 1 a 5 años de edad. Arch Latinoamer Nutr 2008;58(4):377-85.

[10] Akuamoa-Boateng A. Quality protein maize infant feeding trials in Ghana. Ghana: Ghana Health Service, 2002.

[11] Morales Guerra M. Efecto del consumo de maíz de alta calidad proteínica en niño(a)s de familias indígenas de las regiones Mazateca y Mixe del estado de Oaxaca: Una estrategia agronómica de desarrollo entre campesinos que practican agricultura de subsistencia. PhD Thesis. México: Institución de Enseñanza e Investigación en Ciencias Agrícolas, 2002.