

Does dietary diversity improve the quality of infant formula?

Introduction and Objective

In a country such as the DR Congo, where nearly half of all children suffer from malnutrition, the use of nutritional inputs from various local food sources is often presented as an economic strategy and an alternative to imported commercial products. Using linear programming, we attempted to analyze the impact of the diversity of local ingredients on the cost and quality of therapeutic food for children.

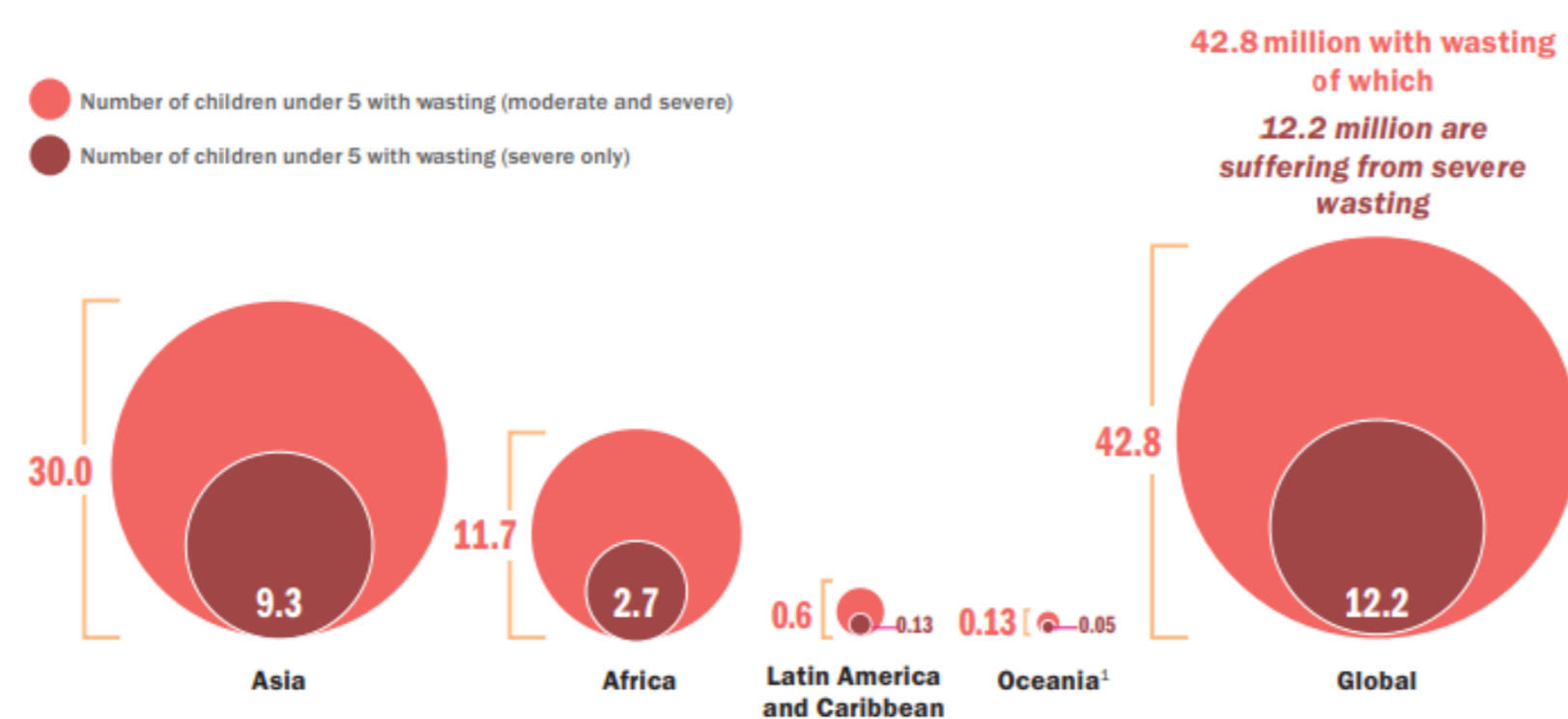


Figure 1: Number of children under 5 affected by wasting and severe wasting. United Nations Children's Fund, World Health Organization, International Bank for Reconstruction and Development/The World Bank. Levels and trends in child malnutrition: UNICEF / WHO / World Bank Group Joint Child Malnutrition Estimates. Key findings of the 2025 edition. Geneva: World Health Organization; 2025.

Methodology

We compiled a ranked list of 12 ingredients that more than 6,000 mothers and caregivers of malnourished children in eastern and central Democratic Republic of Congo would like to see included in infant formula. By formalizing and solving a formulation program using a solver, we successively generated eleven optimized formulations from these twelve ingredients, adding them one by one in order of preference. A thirteenth formulation incorporating a densified resource of essential trace elements was generated. We then analyzed the price evolution of our formulations and their threshold of satisfaction of the 47 nutritional reference constraints for this type of food.



Figure 2: Methodological approach

Results and discussion

Table 1: Formulations generated (mixture, number of ingredients, number of constraints satisfied, percentage of constraints satisfied and price of mixture)

Mixture	Number of ingredients	Number of constraints satisfied	% of constraints satisfied	Mixed price (USD)
Soybeans + Maize	2	12	31,91	0,79
Soybeans + Maize + Peanuts	3	16	34,04	0,84
Soybeans + Maize + Peanuts + Fish	4	18	38,3	0,87
Soybeans + Maize + Peanuts + Fish + Rice	5	18	38,3	0,87
Soybeans + Maize + Peanuts + Fish + Rice + Milk	6	20	42,55	1,57
Soybeans + Maize + Peanuts + Fish + Rice + Milk + Meat	7	20	42,55	1,57
Soybeans + Maize + Peanuts + Fish + Rice + Milk + Meat + Sorghum	8	20	42,55	1,57
Soybeans + Maize + Peanuts + Fish + Rice + Milk + Meat + Sorghum + Cowpeas	9	20	42,55	1,57
Soybeans + Maize + Peanuts + Fish + Rice + Milk + Meat + Sorghum + Cowpeas + Potatoes	10	22	46,8	1,84
Soybeans + Maize + Peanuts + Fish + Rice + Milk + Meat + Sorghum + Cowpeas + Potatoes + Palm oil	11	19	40,43	1,14
Soybeans + Maize + Peanuts + Fish + Rice + Milk + Meat + Sorghum + Cowpeas + Potatoes + Palm oil + Sugar	12	23	48,93	1,69
Soybeans + Maize + Peanuts + Fish + Rice + Milk + Meat + Sorghum + Cowpeas + Potatoes + Palm oil + Sugar + MDR	13	47	100	3,04

MDR : micronutrient-dense resource.

The more diverse a mixture is, the more nutritional constraints (Figure 3), but this improvement is almost always accompanied by a significant increase in cost (Figure 4). The mixture of 12 local ingredients only satisfies 48.93% of 47 nutritional requirements set by the FAO/WHO (2022, 2023), illustrating the difficulty of formulating an optimal food at low cost based solely on these resources. Most of the unsatisfactory constraints were about micronutrients. The addition of a micronutrient-dense resource raises this rate to 100% but approximately doubled the cost of the mixture.

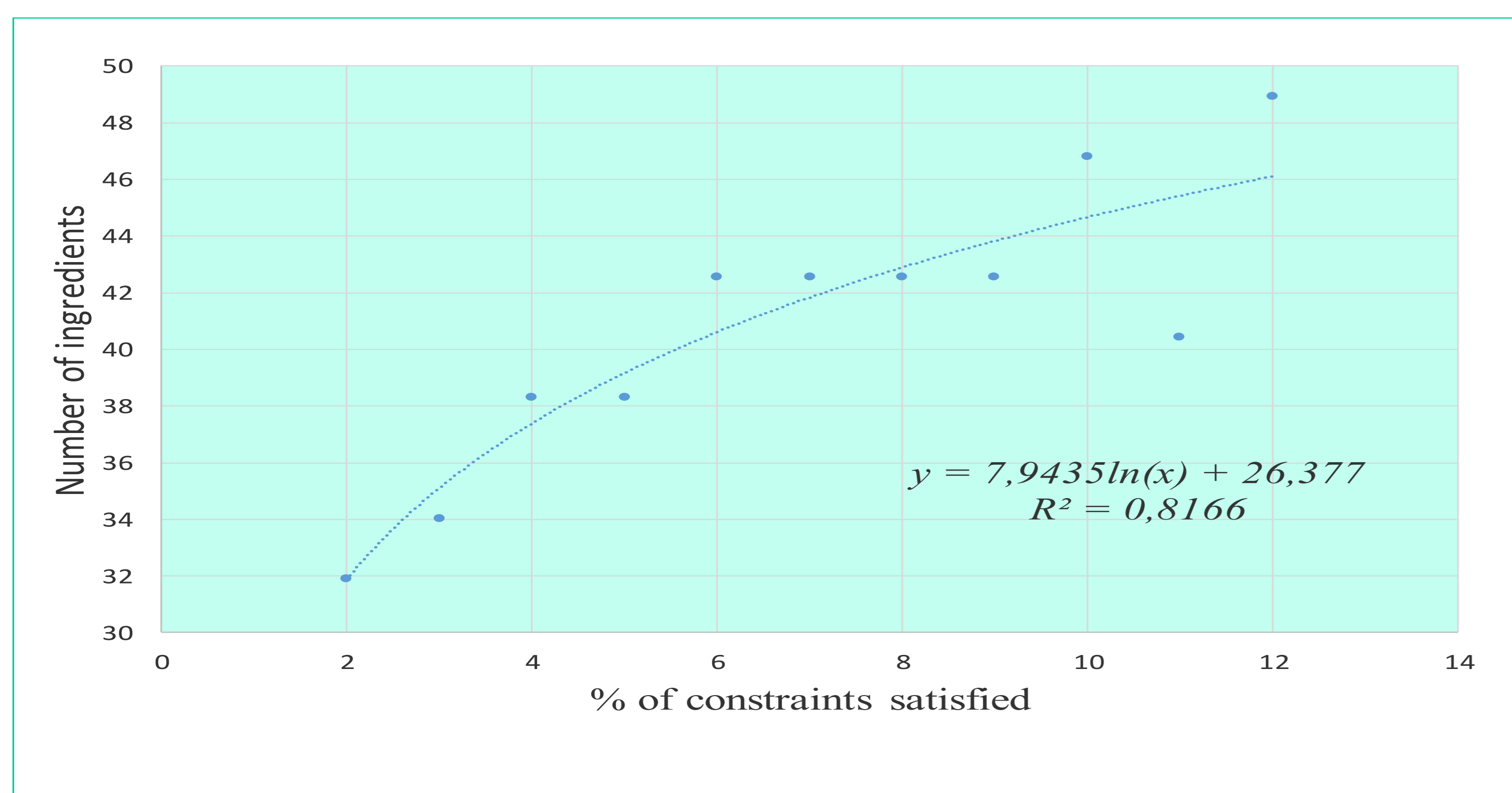


Figure 3: Correlation between the number of ingredients and the percentage of constraints satisfied by the mixture

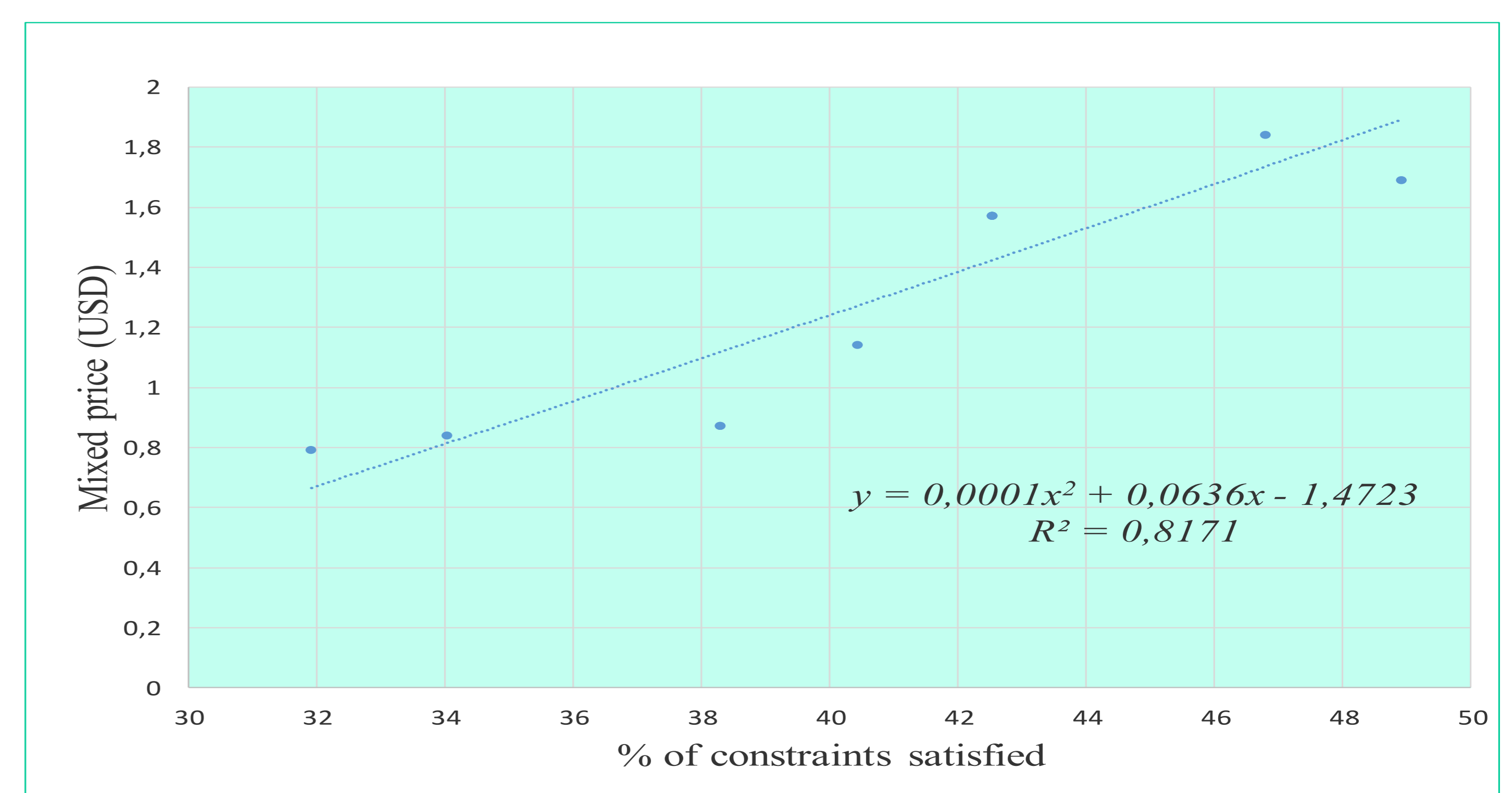


Figure 4: Correlation between the percentage of constraints satisfied and the price of the mixture

Conclusion

Local food diversity is not the only required resources for the formulation of a large satisfied therapeutic infant food adapted to the local context. Resources rich in essential trace elements are needed. These resources deserve special attention from nutrition program managers, as the cost of infant formulas depends on them.

Bibliography

- ✓ FAO-WHO. (2022). *Guidelines for ready-to-use therapeutic foods. Codex Alimentarius Guideline No. CXG 95-2022. Codex Alimentarius Commission.* <https://doi.org/https://doi.org/10.4060/cc4593en>
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