



Original / *Nutrición enteral*

## ILSI Task Force on enteral nutrition; estimated composition and costs of blenderized diets

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### Abstract

Blenderized tube diets (BTD) are used in some parts of Brazil and few studies have analyzed their features in comparison with industrialized preparations. Among 14 randomly collected BTD recipes 9 were poorly described or failed to standardize foodstuffs and portions and, consequently, nutrient and energy composition was difficult to define. Only five BTD allowed theoretical estimation of their nutritional properties. Macronutrient content was highly variable, often conflicting with accepted daily recommendations. According to the literature there are further disadvantages with BTD use including diet high risk of contamination, physical and chemical instability, and high osmolarity and viscosity. Nominal cost of BTD was comparatively low in relation to industrialized formulas; however we did not compute labor and indirect expenses, probably rendering final value more expensive than with the industrialized alternative. It is likely that within such circumstances, hospital and home care malnutrition will not be adequately dealt with and related complications may occur. It is concluded that the continued use of blenderized tube feeding diets requires careful assessment, prioritizing correction of potential nutritional deficits by means of safe, balanced, chemically complete and effective nutritional prescriptions.

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### GRUPO DE ESTUDIOS ILSI SOBRE NUTRICIÓN ENTERAL; COMPOSICIÓN Y COSTOS ESTIMADOS DE DIETAS ARTESANALES

#### Resumen

Dietas enterales artesanales (DEA) son utilizadas en algunas partes de Brasil y pocos estudios analizaron sus características en comparación con las preparaciones industrializadas. De un total de 14 DEA colectadas 9 estaban mal definidas o no establecían claramente los géneros alimenticios y porciones empleados, consecuentemente fue difícil calcular su composición en nutrientes y energía. Solo cinco DEA permitieron una estimativa teórica de sus propiedades nutricionales. El contenido de los macronutrientes era muy variable, y con frecuencia divergente de las recomendaciones diarias aceptadas. De acuerdo con la literatura hay otros inconvenientes en el uso de DEA, o sea elevado riesgo de contaminación, inestabilidad fisicoquímica, y alta osmolaridad y viscosidad de las DEA. El costo nominal de las dietas fue comparativamente bajo en relación a las formulaciones industrializadas, pero los gastos laborales y otros costos indirectos no fueron computados por nosotros, probablemente conduciendo a un valor total final superior al de la alternativa industrializada. Es esperado que en tales circunstancias la desnutrición no quedara bien tratada y complicaciones relacionadas podrán aparecer. La conclusión es que el empleo continuado de dietas artesanales requiere una evaluación criteriosa, con prioridad para la corrección de los déficits nutricionales utilizando prescripciones seguras, balanceadas químicamente, completas y efectivas.

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## Introduction

Malnutrition is a well known risk for patients treated in hospitals, long-term facilities as well as home care<sup>1</sup>. Malnutrition in turn is associated to higher rate of complications, general morbidity and mortality, and prolonged hospitalization when compared to the well-nourished state<sup>2</sup>. Nutritional therapy emerges in this context as an important tool to antagonize hospital malnutrition.

Enteral nutritional therapy (ENT) is widely practiced whenever the patient is unable to use oral feeding, however still enjoys the full or partial ability of absorbing nutrients from the gastrointestinal tract. ENT allows the administration of adequate nutrients thus contributing to alleviate malnutrition with its accompanying infectious complications<sup>3-7</sup>. For more than two decades full resources for enteral nutrition practice have been available in Brazil including ready-to-use diets with defined composition, flexible and biocompatible enteral tubes, and custom-designed infusion pumps, thus permitting safe and reliable enteral nutrition therapy with quality control, both in the nosocomial and the home environment<sup>8-9</sup>.

Nonetheless, blenderized or homebrew tube diets (BTD) are still popular, especially for home use after hospital discharge as well as during home care by specialized health providers<sup>10</sup>. Inside hospitals their use has been decreasing however they are not uncommon in long-term facilities<sup>11</sup>.

Many defend that BTD are more physiological and cost less than corresponding industrialized enteral diets (IED)<sup>12,13</sup>. Yet there is evidence that, in BTD, contamination may be higher, along with physical and chemical instability as well as more cumbersome handling and administration. Microbial colonization may be precipitated during multiple phases encompassing contaminated ingredients and equipment, faulty hygiene of hands and compounding areas, and storage and distribution routines that favor germ proliferation<sup>14</sup>. Ideal calorie and protein density is difficult to achieve, whereas macro and micronutrient profile rarely fulfills all requirements of the patients<sup>12-16</sup>.

By the same token, in BTD there is little or no control of osmolarity and viscosity, contributing to their inefficiency and complications. When offered in diluted form such diets fail to supply sufficient protein and energy, and if given in a more concentrated way digestive intolerance or tube clogging might occur.

Given the importance of this subject it was selected, for a practical and theoretical analysis, by the Task Force on Clinical Nutrition of the International Life Sciences Institute in Brasil (ILSI Brasil). It is the purpose of such institution to discuss solutions for technical and scientific problems relevant to the population as a whole, integrating industries, government, universities and research institutes, within the context of the rights of each patient to receive optimal nutritional care at all times, and the responsibility of the society and specialized health organizations to provide high quality nutrients, in order to foster health and correct malnutrition.

The objective was a practical and theoretical analysis of the nutritional quality and nominal cost of BDT as adopted in Brazil, in the light of available IED alternatives and international guidelines. End points were macronutrients, selected micronutrients, and adequacy regarding daily requirements of the adult population (dietary reference intakes/DRI and Brazilian recommended daily intake/IDR). Cost assessment was incomplete addressing only price of foodstuffs, leaving out labor and other expenditures.

## Methods

Recipes of blenderized enteral feeding were randomly collected in 14 hospitals, however only five were utilized, on account of more precise information about foodstuff amounts (weight in g and volume in ml) along with described manipulation routine, indispensable for dietary assessment. The BTD originated from different Brazilian regions, both in the northern and southern parts of the country, but the authors processed their analysis blinded to the BTD provenience.

Energy value was registered in Microsoft Excel spreadsheets and calculated for each ingredient. In case of undisclosed items such as legume soup, Brazilian internet sources were searched for representative composition (<http://tudogostoso.uol.com.br/categorias/sopas>). Commercial foods were computed according to portion size and manufacturer informations, specifically Mucilon® Nestlé, Nidex® Nestlé, Nutren Active® Nestlé and Sustagen®, Mead Johnson. For macro- and micronutrients the software AVANUTRI PC was employed (Avanutri & Nutrição Serviços e Informática Ltda Me Três Rios/RJ). Results were complemented and confirmed with the help of two Brazilian food composition tables, namely TACO and Phillipi.

Adequacy of macronutrient distribution was classified according to the guidelines of the Brazilian Ministry of Health: carbohydrates: 55-75% of total energy intake (TEI), of which 45- 65% complex carbohydrates and fibers, and <10% of free or simple sugars; lipids: 15-30% of TEI; protein: 10-15% of TEI. Protein and vitamin allowances followed the Brazilian IDR as well as the USA DRI.

Foodstuff costs were searched in commercial providers considering the lowest consumer price: [www.sonda.com.br](http://www.sonda.com.br); [www.farmadelivery.com.br](http://www.farmadelivery.com.br); [www.farmaciamix.com.br](http://www.farmaciamix.com.br). Industrialized diets had their monetary value similarly transcribed from internet consumer sites ([www.nutriservice.com.br](http://www.nutriservice.com.br) and [www.sabordeviver.com.br](http://www.sabordeviver.com.br)), focusing the least expensive option.

## Results

The blenderized tube feeding diets mixed fresh ingredients with selected industrialized complements. All five recipes contained beef or chicken along with

legumes. In three cases cooked beans, green leaves and eggs were added, including whole cooked eggs, cooked egg white, or raw egg yolk. Cow milk and in one case soybean milk were also present. Lipids were supplied by means of soybean oil or corn oil, and in one example by vegetable oil plus margarine.

Sugar was identified in one composition, and industrialized maltodextrine (Nidex®, Nestlé) was part of another one. Additional carbohydrates encompassed oat meal, corn meal or starch, chocolate powder drink, baby cereal (Mucilon®, Nestlé), and complex nutritional supplements Sustagen® Mead Johnson and Nutren Active® Nestlé. Nutritional features of the mixtures can be seen in table I.

Portioning of the diet was not always clear. Two main meals of 300 ml (lunch and dinner) were anticipated along with four smaller meals, to a total of 1400 ml/day.

Aiming to compare the costs with industrialized products, two standard powder preparations were selected. A daily prescription of 1,800 ml (one can) with a calorie density of 1 kcal/ml was initially calculated. The price range for such ready-to-use alternative was 17.55-45.74 Brazilian real (BRL), or approximately 6.5-17 €, with a mean of 31.65 BRL (11.7 €). This value was subsequently corrected to a volume of 1,400 ml (Table III).

Direct comparison with industrialized enteral formulas revealed both lower and higher prices for blenderized mixtures, thus it can be accepted that costs of ingredients are roughly comparable. It is important to emphasize that these are incomplete costs overlooking labor, storage, waste disposal, and requirements for water, electricity and other utilities. In this sense, further studies addressing total costs are crucial to envision the full financial impact of the two methods.

Carbohydrate administration was heterogeneous in this series and only one formulation was close to the minimum recommendations. One hospital only achieved adequate protein allowance, and three of the recipes exceeded lipid intake. These findings, taken together, highlight the nutritional inconsistencies in blenderized diets utilized inside and outside the hospital environment (Table IV).

## Discussion

A variety of dietary compositions emerged from the current analysis. It is worth mentioning that nutritional value of foodstuffs depends on geographical origin, ripeness, season of the year, and methods employed during processing, storage and cooking<sup>18</sup>.

**Table I**  
*Macro- and micronutrients of homebrew and industrialized diets*

Nutrients	Homebrew					Industrialized	Industrialized
	A	B	C	D	E	1(*)	2(*)
Protein (g)	92,89	192,85	167,04	130,24	63,66	40g/L	36g/L
Calcium (mg)	925,6	1488,4	1429	2186,2	1273,2	670mg/L	590mg/L
Iron (mg)	5,6	18,9	8,36	26,5	3	12mg/L	11mg/L
Zinc (mg)	8,21	20,31	21,7	25,5	13,2	18mg/L	11mg/L
Vitamin C (mg)	62,7	240	248,1	73,56	301,8	140mg/L	62mg/L

(\*) Standard powder diets (density 1,0 kcal/mL) available in the Brazilian market.

**Table II**  
*Adequacy of homebrew mixtures according to DRI and Brazilian IDR*

Nutrient	IDR	DRI		Homebrew A	Homebrew B	Homebrew C	Homebrew D	Homebrew E
		31-50 years/ male and female*	51-70 years/ male and female*					
Protein (g)	50	46 (F)/56 (M)	46 (F)/56 (M)	92.89 <sup>α</sup>	192.85 <sup>α</sup>	167.04 <sup>α</sup>	130.24 <sup>α</sup>	63.66 <sup>α</sup>
Calcium (mg)	1000	1000	1200	925.6 <sup>γ</sup>	1488.4 <sup>α</sup>	1429 <sup>α</sup>	2186.2 <sup>α</sup>	1273.2 <sup>α</sup>
Iron (mg)	14	8 (M)/18 (F)	8 (M/F)	5.6 <sup>γ</sup>	18.9 <sup>β</sup>	8.36 <sup>β</sup>	26.5 <sup>α</sup>	3 <sup>γ</sup>
Zinc (mg)	7	11 (M/F)	11 (M)/8 (F)	8.21 <sup>α</sup>	20.31 <sup>α</sup>	21.7 <sup>α</sup>	25.5 <sup>α</sup>	13.2 <sup>α</sup>
Vitamin C (mg)	45	75 (F)/90 (M)	75 (F)/90 (M)	62.7 <sup>γ</sup>	240 <sup>α</sup>	248.1 <sup>α</sup>	73.56 <sup>γ</sup>	301.8 <sup>α</sup>

\*depends on gender and age

(α) exceeds IDR and/or DRI

(β) meets IDR and/or DRI

(γ) doesn't meet IDR and/or DRI

**Table III**  
*Cost of foodstuffs of homebrew and industrialized products*

Nutrients	Daily cost (BRL\$)*	Mean cost of powder industrialized products (BRL\$)**
Homebrew A	8.59	31.65 (400g or 1800 Kcal)
Homebrew B	30.88	18.06 (1000 Kcal)
Homebrew C	16.50	25.28 (1400 Kcal)
Homebrew D	18.88	
Homebrew E	14.34	

\* Values estimated according to corresponding hospital guidelines for discharged patients (6-9 meals/day); Cost based on www. sonda.com.br; www.farmadelivery.com.br and www. farmaciamix.com.br, accessed 12/9/2012.

\*\*Cheapest consumer price of two commercially available diets. Based on www. nutriservice.com.br and www. sabordeviver.com.br. Accessed 12/17/2012; Obs: € = 2.70 BRL.

Full chemical analysis of blenderized diets could be a useful procedure to establish, even though approximately, the real composition of the BTD feeding. Given the possible external influences already alluded to, discrepancies between lots would still not be ruled out. Nevertheless this would represent an important step, providing health care professionals with fundamental information about the nutritional value of the prescribed diet. Of course such a pitfall doesn't exist with industrialized preparations, which are stable and well defined, thus ensuring that each prescribed nutrient is actually delivered to the patient.

Other authors similarly resent the variability of nutritional composition of blenderized feedings<sup>12</sup>. Mokhalalati et al. investigated three homebrew diets in Saudi Arabian hospitals. Not only differences from one institution to another were detected, but also they happened within the same hospital. Fluctuations in the range of 16-50% occurred in the same hospital. Moreover, inadequacies were present regarding 12 nutrients, when compared to the theoretical recipe<sup>12</sup>. Another problem concerned energy density, which was variable depending on the availability of foodstuffs. Calculated

values did not meet the nutritional requirements of the population<sup>1</sup>.

Also in the experience of Henriques et al., low energy density of homebrew diets was a concern<sup>19</sup>. The objective of their study was the preparation of diets with adequate osmolarity. Indeed values of 250-400 mOsm/kg were achieved, however calorie density often lagged behind, with a range of 0.60-1.08 kcal/ml corresponding to low to normal energy density according to the ESPEN directives<sup>20</sup>.

It becomes clear that production of hypercaloric BTB incurs the risk of osmolarity exceeding 400 mOsm/kg and elevated viscosity. Such hypothesis is compatible with the findings of Mokhalalati et al.<sup>12</sup> of viscosity (2,000-4,000 centipoise) and osmolarity (607 ± 204 mOsm/Kg). Industrialized diets typically exhibit values of just 10 centipoise, highlighting the virtual impossibility of administering such high viscosity fluids.

One should admit that blenderized tube feeding diets are flexible, permitting free selection of ingredients to reach adequate nutritional value; however this advantage is offset by excessive manipulation during the multiple compounding phases. The consequence is higher microorganisms contamination and also more expenses, as these are labor-intensive steps. Microbiological details were out of the scope of our study and also financial calculations were limited to foodstuff prices only. All this facts notwithstanding, these are relevant points that deserve further studies.

The raw components of the homebrew diet are a natural source of contamination, and aseptic environments, materials and handling procedures during diet compounding cannot always be taken for granted<sup>15</sup>. Mauricio et al. noticed 100% contamination by fecal coliforms in BTB from two hospitals, besides molds and fungi in unacceptable concentrations. Both raw materials and excessive manipulation were incriminated, in agreement with other investigations<sup>16,21,22</sup>.

Again Freedland et al.<sup>24</sup> registered 30-90% contamination in an open system of blenderized diets administered by continuous drip, which was associated with poor aseptic technique, inadequate cleaning and disinfection of

**Table IV**  
*Macronutrient composition of the diets*

Products						Industrialized	Industrialized
	Homebrew A	Homebrew B	Homebrew C	Homebrew D	Homebrew E	1(*)	2(*)
Protein 10-15% TEI	29.11%	39.78%	14.46%	24.10%	16.72%	16%	14%
Carbohydrate 55-75% TEI	40.45%	41.58%	22.79%	29.94%	53.06%	50%	56%
Fats 15-30% TEI	30.45%	18.64%	62.74%	45.96%	30.22%	34%	30%

Abbreviations: TEI – Total energy intake.

(\*) Standard powder diets (density 1.0 kcal/mL) available in the Brazilian market.

compounding equipment, and contaminated ingredients added to the diet. Manipulation and dilution procedures increased the risk of contamination, coinciding with other publications who focus blenderized diet contamination as a risk factor for nosocomial infections<sup>12,25,26</sup>.

In addition to susceptibility to bacterial proliferation, blenderized tube feeding diets may cost more. In the current protocol only purchased components were taken in account however, many more items are relevant. Silkroski et al. conducted a survey on costs of tube feeding in academic hospitals in the USA<sup>27</sup>. They were particularly interested in hidden costs. Labor and working time corresponded to 34% of the total expenditures in the open system (including blenderized diets), due to more prolonged manipulation and more frequent diet changes. More bags and given sets were consumed during such changes, representing 23% of the expenditures. Foodstuffs and nutrients did not exceed 43% of the financial estimates, thus confirming that labor and non-nutritional resources were responsible for most of the total costs. The closed system (ready to use products) was substantially cheaper, the difference between the two amounting to 46%<sup>27</sup>.

Measurement of labor costs, including time required for each compounding step, is often a challenge. One example is home dietary counseling for patients discharged from the hospital. A survey with 1,100 professionals revealed that dietitians are typically engaged in such activity, and 2.8 hours are needed for each patient<sup>27</sup>.

The information collected in the current protocol suggest that blenderized tube feeding diets are not necessarily cheaper than industrialized formulations, and would very likely exceed them, should indirect expenditures be calculated. Quality of nutritional support is another concern. In the study of Silkroski et al., the gap between prescribed and administered feedings tended to be larger when homebrew mixtures were adopted<sup>34</sup>. Even in hospitals, failure to supply the full prescription is not uncommon, on account of gastrointestinal complications as well as frequent discontinuation of gavage because of diagnostic tests and other procedures<sup>29,34</sup>.

In two investigations as little as 50% of the estimated volume was effectively supplied<sup>30,34</sup>, a fact that could interfere with success of nutritional therapy, thus enhancing morbidity, mortality, length of hospitalization, and global healthcare costs<sup>2</sup>. In case of outpatient care, the dangers are increased hospital admissions and higher needs for medical assistance during homecare<sup>35</sup>. The inconsistencies in the composition of blenderized diets in this experience, which match those described by others<sup>12,27</sup>, could compromise adequate nutrition with all the attending troubles of ongoing malnutrition.

## Conclusion

Many reflections and discussions arise from the current study. Blenderized tube feeding diets were demonstrated to be highly variable and with inconsis-

tent nutrient composition, two circumstances that hinder effective nutritional therapy. Preliminary cost assessment failed to confirm the widely announced benefit with regard to industrialized products.

Although not addressed in this protocol, other concerns related to BTD deserve to be mentioned such as excessive manipulation, increased risk of contamination, physical and chemical instability and higher osmolarity and viscosity. Labor and overhead are likely to be substantially higher, thus elevating total expenditures and reversing any theoretical savings. The consequences could also include more frequent complications and failure to correct malnutrition, thus perpetuating the disease.

This is a major challenge, and priority should be allocated to effective patient nutritional care and high quality of health services. Nutritional therapy demands quality control and patient monitoring at all times. Dietary products should be clearly labeled with regard to composition, origin and manipulation. Enteral access such as nasal tubes or ostomies deserves attention, along with administration routines and general clinical and biochemical monitoring<sup>21</sup>. Detailed protocols are recommended in order to curtail complications and improve the outcome of nutritional replenishment.

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ILSI Brasil was founded in 1990 and it is one of the regional branches of the International Life Sciences Institute. It is a permanent forum for discussion and updating of knowledge in technical-scientific area, by joining efforts from scientists from academia, government, and industry. It currently has 34 member companies, including the main players in the food industry, acting through scientific committees and task forces. Its activities contribute to a better understanding of topics related to nutrition, food safety, toxicology, risk assessment, and the environment.

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