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Nutritional composition of closed-system enteral nutrition formulations available in Brazil

Composição nutricional de formulações de nutrição enteral em sistema fechado disponíveis no Brasil

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ABSTRACT

Introduction: Enteral nutrition is widely used in hospitalized patients who are unable to meet their nutritional requirements orally. However, there is lack of information regarding the nutritional composition of commercially available closed-system enteral nutrition formulations in Brazil and their alignment with nutritional recommendations. **Objective:** To analyze the nutritional composition of closed-system enteral nutrition formulations available in Brazil and to evaluate their nutritional profile in relation to current dietary recommendation. **Material and Methods:** This descriptive study analyzed nutritional information from product labels, manufacturers' portfolios, and official websites of all closed-system enteral nutrition marketed between 2024 and 2025 from three manufacturers with commercially available portfolios in Brazil, to characterize macronutrient quantity and sources and to evaluate micronutrient content in relation to national and international recommendations. Pearson correlation, ANOVA and Kruskal-Wallis were conducted with SPSS software version 23.0. **Results:** Forty-two enteral nutrition formulations were analyzed. All samples provided micronutrient levels recommended by Brazilian legislation, except for vitamin D. Maltodextrin was the main carbohydrate source, and glucose syrup was present in five samples. Fiber was present in 57%, with a predominance of soluble fibers. Calcium caseinate was the main protein source, and only 21.4% of the samples had a blend of animal and plant-based proteins. Sunflower and canola oils were the main lipid sources, and 61.9% of the formulations contained fish oil. **Conclusion:** Enteral nutrition formulations generally meet micronutrient regulatory standards; however, their macronutrient composition is characterized by a predominance of maltodextrin and a lower presence of protein blends and lipid sources with potential anti-inflammatory properties.

Keywords: Enteral nutrition; Food, formulated; Food Labeling; Nutritional Requirements

RESUMO

Introdução: A nutrição enteral é amplamente utilizada em pacientes hospitalizados que não conseguem suprir suas necessidades nutricionais por via oral. No entanto, não há informação disponível sobre a composição nutricional das formulações de nutrição enteral em sistema fechado comercialmente disponíveis no Brasil e sua adequação às recomendações nutricionais. **Objetivo:** Analisar a composição nutricional das formulações de nutrição enteral em sistema fechado disponíveis no Brasil e avaliar seu perfil nutricional em relação às recomendações nutricionais atuais. **Material e Métodos:** Este estudo descritivo analisou informações nutricionais de rótulos de produtos, portfólios de fabricantes e sites oficiais de todas as formulações de nutrição enteral em sistema fechado comercializada entre 2024 e 2025 por três fabricantes com portfólios disponíveis comercialmente no Brasil, para caracterizar a quantidade e as fontes de macronutrientes e avaliar o conteúdo de micronutrientes em relação às recomendações nacionais e internacionais. Correlação de Pearson, ANOVA e teste de Kruskal-Wallis foram conduzidos com o software SPSS versão 23.0. **Resultados:** Quarenta e duas formulações de nutrição enteral foram analisadas. Todas as amostras apresentaram níveis de micronutrientes recomendados pela legislação brasileira, com exceção da vitamina D. A maltodextrina foi a principal fonte de carboidrato, e xarope de glicose esteve presente em cinco amostras. Fibras estiveram presentes em 57% das formulações, com predomínio de fibras solúveis. O caseinato de cálcio foi a principal fonte de proteína, e apenas 21,4% das amostras continham uma mistura de proteínas de origem animal e vegetal. Os óleos de girassol e canola foram as principais fontes lipídicas, e 61,9% das formulações continham óleo de peixe. **Conclusão:** As formulações de nutrição enteral geralmente atendem aos padrões regulamentares de micronutrientes; no entanto, sua composição de macronutrientes é caracterizada por uma predominância de maltodextrina e uma menor presença de misturas de proteínas e fontes lipídicas com potenciais propriedades anti-inflamatórias.

Palavras-chave: Nutrição Enteral; Alimentos Formulados; Rotulagem de Alimentos; Necessidades Nutricionais

INTRODUCTION

Clinical and metabolic changes resulting from critical illness, inflammatory and hypercatabolic processes, and medical treatment, including neuromuscular blockers and corticosteroids, can lead to malnutrition and sarcopenia (characterized by depletion of strength and muscle mass), which increases the risk of a worse clinical prognosis.[1,2] Dysglycemia is another complication that can impact the immune and inflammatory response, as well as nutritional status.[3] Consequently, both malnutrition and Intensive Care Unit acquired weakness (ICU-AW) are associated with increased morbidity and mortality, as well as reduced quality of life.[4]

Dietary components such as macronutrients, vitamins, minerals, and bioactive compounds can modulate inflammation, oxidative stress, and immunity.[5] An adequate energy and protein intake can contribute to the prevention of malnutrition and sarcopenia, especially about amino acid composition and the role of leucine in stimulating protein synthesis.[3-6] However, gastrointestinal symptoms may affect tolerance to nutritional therapy and absorption of provided nutrients. The composition of enteral nutrition formulations, particularly their protein sources, has been suggested as a factor that may influence these symptoms.[6]

Hospitalized patients may have insufficient oral food intake or an inability to feed themselves orally, indicating the need for enteral nutrition therapy. In Brazil, three major manufacturers supply closed-system enteral nutrition (EN) formulations, which are typically classified according to caloric density, protein content, nutrient complexity, and clinical indication, and are generally described as nutritionally complete.[7] However, these products are developed and manufactured in different regions of the world, which may result in variations in ingredients and production technologies. Despite the widespread use of EN in hospital and home settings, information regarding the composition of commercially available formulations and their alignment with nutritional recommendations remains limited.

A comprehensive characterization of these formulations may contribute to a better understanding of their nutritional profiles and support informed selection of enteral nutrition products.

Therefore, this study aimed to analyze the nutritional composition of closed-system EN formulations available in Brazil and to evaluate their nutritional profile in relation to current dietary recommendations.

MATERIAL AND METHODS

This descriptive study was based on a documentary analysis of nutritional information obtained from manufacturers' portfolios, product labels, and official company websites of enteral nutrition (EN) formulations available in Brazilian market. All closed-system EN formulations marketed between 2024 and 2025 from three manufacturers with commercially available portfolios in Brazil (Danone®, Nestlé®, and Fresenius Kabi®) were included in the analysis. All formulations had complete nutritional information available in the consulted sources. Information regarding leucine content was not available in the consulted sources. Therefore, the manufacturers were contacted to obtain this information; however, one company did not respond. The products were categorized according to their characteristics (e.g., variations in caloric density, protein content, and nutrient complexity) and clinical indication, and the quantity and sources of macronutrients were analyzed.

To assess the amount of micronutrients, we standardized the analysis to the amount provided for every 1500 kcal of EN, the most common target for hospitalized patients according to the European Society for Clinical Nutrition and Metabolism (ESPEN),[8,9] and then we assessed adequacy according to recommendations for micronutrient content in EN formulations by the same society and by the Collegiate Board Resolution (CBR nº 21, may 13, 2015) from the National Health Surveillance Agency, a Brazilian regulatory agency linked to the Ministry of Health.[10]

Data were tabulated and analyzed using SPSS software version 23.0, with values expressed as mean ± standard deviation and median and interquartile range according to the normality of the variable, analyzed via histograms and Shapiro-Wilk test. Pearson's correlation was performed to relate the leucine content to that of protein in the formulations. ANOVA was used to compare the percentage of monounsaturated fatty acids among the EN (followed by Levene's test to analyze the homogeneity of variances and post hoc Hochberg's GT 2), and Kruskal-Wallis with Bonferroni correction for saturated fatty acids and percentage of fish oil. Mann-Whitney was used to verify whether the carbohydrate percentage of EN for glycemic control was different from the others.

RESULTS

Forty-two EN formulations were analyzed, the majority of which had polymeric characteristics (Table 1). In general, the evaluated formulations met the ESPEN recommendations regarding the quantity of nutrients with immunomodulatory, antioxidant, and anti-inflammatory action, except for vitamin D. Furthermore, the hypercaloric formulations did not offer the minimum amount of folate. However, when considering Brazilian legislation, all samples met the recommendations (Table 2).

Table 1: Main characteristics of enteral nutrition formulations available for use in Brazilian ICUs (n=42)

Enteral Nutrition	n	%
Oligomeric	6	14.3
Polymeric, normocaloric and normo-protein	5	11.9
Polymeric, hypercaloric and normo-protein	6	14.3
Polymeric, hypercaloric and high-protein	10	23.8
Polymeric, immunomodulatory	4	9.5
Polymeric, for glycemic control	7	16.7
Polymeric, specific to other clinical conditions*	4	9.5

Legend: Intensive Care Unit (ICU); * Gastrointestinal tract disorders, liver disease, kidney disease.

Table 2: Content of nutrients with immunomodulatory, antioxidant and anti-inflammatory action in 1500 kcal of enteral nutrition formulations available for use in Brazilian ICUs (n=42)

EN	Oligomeric (n=6)	PNN (n=5)	PHN (n=6)	PHH (n=10)	Immuno-modulatory (n=4)	For GC (n=7)	Others* (n=4)	Average of each nutrient	ESPEN (In 1500 kcal)	CBR 21/2015 (in 1500 kcal)
Vitamin A (µg)	1270±60.6	1227±6.7	1079±221	988±234	1435.6±509	1097±119.7	895.7±412	1122±275	900–1500	450-2250
Thiamine (mg)	2.4±0.7	1.8±0.4	2±0.5	1.9±0.5	2.6±0.9	2.4±0.8	2±0.6	2.17±0.7	1.5–3	0.9-8.25
Riboflavin (mg)	2.9±0.6	2.7±0.5	2.5±0.8	2.4±0.6	2.6±0.3	2.3±0.4	2.5±1.1	2.5±0.6	1.2	1.05-8.1
Niacin (mg)	23.3±10	26.7±1.2	22.3±4.9	22.5±5.3	26.5±2.5	24.9±2.4	18.8±5.6	23.5±5.6	18–40	12-58.5
Pyridoxine (mg)	3.06±0.7	2.7±0.2	2.4±0.6	2.2±0.5	3.2±1.2	2.5±0.2	3.8±2.7	2.7±1.03	1.5	1.05-75
Folate (µg)	375±55.6	345±55.1	292±89.4	318.7±63	485.5±215.7	398.7±117	353.5±184	358±115	330–400	204-765
Vitamin B12 (µg)	9.7±6.1	4.65±1.4	4.8±2.33	4.05±1.3	5.88±4.7	15±22.9	4.3±2.1	6.98±10	2.5	1.8-27
Vitamin C (mg)	191.7±42.2	121±26.3	157.3±55.7	118±42.2	564.4±365	194.6±101	124±58	190±169	100	34.5-1500
Vitamin D (µg)	17±3.9	21.3±6	17.3±6.3	17±3.3	15.5±4.7	14.7±4.8	15.4±6.7	16.9±4.9	25	3.75-37.5
Vitamin E (mg)	27.5±7	22.5±2.8	26.3±6.9	21.8±6.5	82.7±42	40(37-77)	25.9±9.7	36.3±30	15	7.5-750
Iron (mg)	22.2±3.9	22.5±1.8	20.7±4.2	19.6±4.5	21.5±1.9	20.5±2.2	17.3±5.1	20.6±3.7	18–30	10.5-34.5
Magne-sium (mg)	359.6±62.5	363±16.4	398.2±50.3	252.6±59	380.8±29.8	318.9±48.2	301.6±38	315.5±64	-	195-540
Selenium (µg)	108.1±21.1	92.7±6.8	90.33±24	83.6±16	131.7±27.6	99.3±15.9	97.4±32	97.6±23	50–150	25.5-300
Zinc (mg)	19.2±3.5	18**	16.3±2.1	16±2.9	29.2±8.9	16.3±2.4	14.8±3.5	17.9±5.1	10	5.25-30

Legend: EN: Enteral Nutrition | ESPEN: European Society for Clinical Nutrition and Metabolism | CBR: Collegiate Board Resolution | PNN: polymeric, normocaloric and normo-protein | PHN: polymeric, hypercaloric and normo-protein | PHH: Polymeric, hypercaloric and high-protein| GC: glycemic control

* Specific to gastrointestinal tract disorders, liver disease, kidney disease | ** Same value in all formulations with this characteristic. Values expressed as mean ± standard deviation and as median and interquartile range according to data distribution.

Formulations contained an average of 147±32.8 g/L of carbohydrate, corresponding to 46.8% (37-48) of the total energy value (TEV), which differed significantly (p=0.003) from EN for GC (37±4.31%) (Table 3). Regarding carbohydrate source, maltodextrin was the predominant component in the analyzed formulations (83.3%), including those indicated for glycemic control, and was used as the sole carbohydrate source in more than half of the products. Glucose syrup and tapioca starch were less frequently identified, with tapioca starch mainly present in formulations indicated for glycemic control. Only one formulation, indicated for cancer patients with cachexia, contained sucrose as part of its carbohydrate composition. However, this product contained anti-inflammatory compounds, such as fish oil (29% of the total dietary lipids) and saffron oil, with an n6: n3 ratio of 1.5:1.

Dietary fiber was present in 57% (n=24) of the analyzed products and was identified in only one oligomeric formulation (0.5 g/L) and in all GC EN, which presented higher amounts of it (Table 3). The median in the samples was 11 g/L (0-15), with a predominance of soluble fiber (61%; 47.5-80) over insoluble fiber (39%; 20-52.4), whereas the first included inulin, guar gum, resistant starch type 4 from tapioca fiber, fructooligosaccharide, soy fiber, and wheat; and the second cellulose, soy fiber, and wheat.

Enteral nutrition had an average of 63.3±17.67 g/L of protein, corresponding to 20% (16-20) of the TEV/liter of formulation (Table 3). Formulation labeled as normoproteic provided, on average, 16.3±1.4% of total energy from protein, whereas high-protein provided 20±4.8%. Calcium caseinate was the main protein source in 50% of the analyzed formulations and was predominantly present in polymeric, hypercaloric, and high-protein EN. Only one (immunomodulatory) had glutamine dipeptide as the main protein source, and the other with this characteristic had other nutrients in their composition with antioxidant, anti-inflammatory and immunomodulatory functions in the body, such as fish, linseed, and saffron oils, vitamins A and E, and selenium (Table 3).

Among the samples, 31% (n=13) contained at least 25% whey protein in their composition. Only 16.7% (n=7) had a protein blend with four protein sources (P4) of animal and vegetable origin in similar proportions (with each source contributing at least 20% of the total), the largest being whey protein concentrate (35%), followed by calcium caseinate (25%), pea protein isolate (20%), and soy protein (20%). All formulations

Table 3: Main sources of macronutrients in enteral nutrition formulations available for use in Brazilian ICUs (n=42)

EN	Oligomeric (n=6)	PNN (n=5)	PHN (n=6)	PHH (n=10)	Immuno-modulatory (n=4)	For GC (n=7)	Others* (n=4)	Total/ Average
Main carbohydrate source (CHO)								
Maltodextrin	6	5	6	8	4	3	3	35(83.4%)
Glucose syrup	0	0	0	2	0	0	1	3(7.1%)
Tapioca starch	0	0	0	0	0	3	0	3(7.1%)
Isomaltulose	0	0	0	0	0	1	0	1(2.4%)
Average CHO (g/L)	151.3±42	126.2±8.8	184.6±26	157.4±19	127.5±9.6	114±1.6	168±35.1	147±32.8
% TEV/L of EN	51.3±14	50.5±3.5	50.6±4,3	42±6.15	46±6.3	37±4.3	43.2±9.6	46.8(37-48)
Presence of fiber	1	3	2	6	2	7	3	24 (57%)
Amount (g/L)	0.5	15(0-17)	4(0-15)	7.5(0-15)	7.5(7-15)	1 (15-15)	11(2.5-18)	11(0-15)
Insoluble (%)	0	52(51-55)	33(26.5-39)	52(52-52.4)	**	21(20-21,8)	45(15-75)	39(20-52.4)
Soluble (%)	100	47(29-49)	67(61-73.5)	47.5(47-48)	**	79(78-80)	55(25-85)	61(47.5-80)
Main protein source (PTN)								
Hydrolyzed whey	6	0	0	0	1	0	0	7(16.7%)
Isolated from soybeans	0	1	0	0	0	1	1	3(7.1%)

Main protein source (PTN)								
Calcium caseinate	0	0	4	6	2	6	3	21(50%)
Whey and soy in similar proportions	0	2	0	1	0	0	0	3(7.1%)
Milk, peas and soy in similar proportions	0	2	2	3	0	0	0	7(16.7%)
Glutamine dipeptide	0	0	0	0	1	0	0	1(2.4%)
P4	0	2	2	3	1***	0	1***	9(21.4%)
Average PTN (g/L)	63±18.7	38.8 ±1	60±2.6	76±14.3	65.5±19			63.3±17.67
% TEV/L of EN	21.6±7.6	15.5±0.4	16.7±1.7	20±4.8	22.9±1.4	19.5±1.9	17.4±6.3	20(16-20)

Legend: EN: Enteral Nutrition | PNN: polymeric, normocaloric and normo-protein | PHN: polymeric, hypercaloric and normo-protein | PHH: Polymeric, hypercaloric and high-protein| GC: glycemic control | TEV: Total Energy Value | P4: protein blend with four protein sources | * Specific to gastrointestinal tract disorders, liver disease, kidney disease | ** 1 formulation had 100% soluble fiber, and the other 100% insoluble fiber. The other 2 did not have fiber | *** Presence of P4, but with different proportions between the protein sources | Values expressed as mean ± standard deviation and as median and interquartile range according to data distribution.

from one brand were polymeric and had P4 in similar proportions, with 2 being normocaloric and the others hypercaloric. Additional formulations from other brands also contained P4 blends, with variations in protein proportions and the inclusion of specific amino acid sources, such as arginine, in selected products.

Only two brands provided information regarding leucine content in the formulations analyzed (n=22 products), with an average of 6.4 ± 2.4 g/liter. There is a strong correlation (r=0.811; p=0.00) between leucine and protein content (Figure 1).

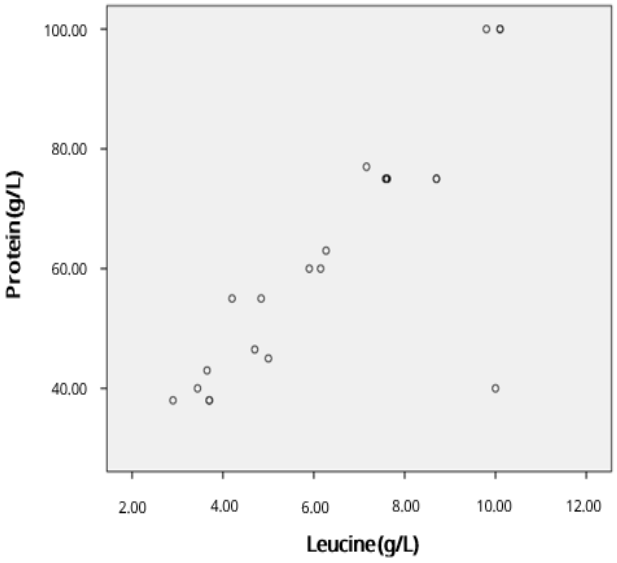

Figure 1: Correlation between protein and leucine content in the main enteral nutrition formulations available for use in Brazilian ICUs (n=22).

Medium-chain triglyceride (MCT), sunflower oil, and canola oil were the main sources of lipid in the analyzed EN (Table 4). No formulation contained trans-fat.

The median contents of saturated fatty acid (SFA) and monounsaturated fatty acid (MUFA) were 8 g/L (4-15) and 18 g/L (10-30) g/liter, corresponding to 7.4±6.5% and 14±7.9% of the TEV, respectively. The median omega-3 content was 2 g/L (1.15–2.77), and the omega-6: omega-3 ratio was 4.79:1 (3.4:1–6.1:1). Fish oil was present in 61.9% (n = 26) of the formulations.

Oligomeric EN showed a lower percentage of MUFA (2.7%; 1.7–5.1%) compared with the others ($p < 0.05$), except for immunomodulatory formulations and those indicated for other clinical conditions. Immunomodulators presented higher MUFA (6.98%; 2.4-11.9%), with a significant difference from normocaloric and normoproteic polymeric EN ($p = 0.046$), and from GC ($p = 0.00$). There was no difference in the SFA between the formulations ($p = 0.620$). The proportion of fish oil varied significantly between formulations ($p = 0.015$), with immunomodulatory EN presenting the highest values, although this difference was not evident in the bivariate analysis. Oils with immunomodulatory or anti-inflammatory properties were absent in 40.5% (n = 17) of the samples.

Table 4: Lipid profile of enteral nutrition formulations available for use in Brazilian ICUs (n=42)

EN	Oligomeric (n=6)	PNN (n=5)	PHN (n=6)	PHH (n=10)	Immuno-modulatory (n=4)	For GC (n=7)	Others* (n=4)	Total n (%)
Main lipid source (LIP)								
MCT	5	0	0	2	2	0	0	9 (21.5)
Sunflower oil	0	4	3	5	0	4	0	16 (38.1)
Canola oil	0	1	3	3	1	3	2	13 (30.9)
Soybean oil	0	0	0	0	0	0	1	1 (2.4)
Mix of oils in similar proportions	1	0	0	0	1	0	1	3 (7.1)
Average of LIP (g/L)	37.5±14	36.4±2.5	50.8±7.9	64.5±21.7	40±16	59±14.8		52±19.3
% TEV/L of EN	27.9±7.4	32.7±2.2	31.4±3.7	37.3±6.5	31.1±4.9	42.4±4.7	38.4±5.4	
Presence of oils with								
Saffron oil	2	0	0	0	1	0	1	4 (9.5)
Linseed oil	0	0	0	2	1	0	0	3 (7.1)
Fish oil	3	5	4	8	2	3	1	26 (61.9)
None	4	0	2	2	2	4	3	17 (40.5)
% Fish oil	11.4±11	2.8±0.3	2.7±1.3	2.7±0.7	20.5±7.8	5.5±4.8	34	3 (2.5-4.6)

Legend: EN: Enteral Nutrition | PNN: polymeric, normocaloric and normo-protein | PHN: polymeric, hypercaloric and normo-protein | PHH: Polymeric, hypercaloric and high-protein| GC: glycemic control | MCT: Medium-chain triglyceride | TEV: Total Energy Value Values expressed as mean ± standard deviation and as median and interquartile range * Specific to gastrointestinal tract disorders, liver disease, kidney disease.

DISCUSSION

Considering the role of nutrients in modulating inflammation, oxidative stress, and mitochondrial function, understanding the nutritional composition of enteral nutrition (EN) formulations may be relevant.[11] Previous studies have evaluated specific enteral nutrition formulations or focused on specific nutrients/ disease and were conducted in different geographic contexts.[11-17] In contrast, the present study analyzed the nutritional composition of commercially available enteral nutrition formulations in the Brazilian market, considering both macronutrient characteristics and micronutrient content in relation to current nutritional recommendations.

In general, the analyzed formulations met the micronutrient levels required by Brazilian and European legislation. However, vitamin D was the only nutrient with amounts lower than those recommended by ESPEN, a relevant finding given the high prevalence (40–70%) of vitamin D deficiency among hospitalized patients, particularly those in critical condition.[18] ESPEN recommendations emphasize the importance of ensuring adequate micronutrient intake during enteral nutrition therapy and recommend considering supplementation in cases of very low caloric intake (and, consequently, lower volumes of enteral nutrition).[19]

Regarding macronutrients, the carbohydrate content of the analyzed formulations showed relatively small variation, with similar percentages of total energy value (TEV) across products. In contrast, Church et al.[16] reported a wide variation in the carbohydrate content of enteral nutrition formulations available in the United States, ranging from 40 to 70% of TEV. As in our study, lower percentages were indicated in products for glycemic control (35-40% of TEV). Beyond total carbohydrate content, the source of this macronutrient is particularly relevant in critically ill patients. Exacerbated inflammatory response and increased secretion of counter-regulatory hormones contribute to endogenous glucose overproduction and insulin resistance in critically ill patients.[3] In this context, an assessment of the quantity and sources of carbohydrates in EN formulations may be relevant in the context of glycemic management. Enteral formulas designed for glycemic control are characterized

by reduced carbohydrate content and the inclusion of carbohydrates with slower digestion and absorption, features that have been associated with improved glycemic control in previous studies.[20,21]

Maltodextrin, a rapidly absorbed carbohydrate,[22] was the main carbohydrate source identified in our samples. A systematic review by Almutairi et al.[23] reported that studies evaluating maltodextrin as a food additive or placebo described changes in microbial composition and inflammatory markers; however, the results were heterogeneous, with increases and decreases in different bacterial genera, and the clinical implications of these changes remain uncertain. Fiber has been shown to modulate gut microbial activity and compositionfao.[24] Despite the widespread use of polymeric, hypercaloric, and high-protein formulations in hospital settings, fiber was present in only 60% of the formulations analyzed and in relatively low amounts.[27] Although ESPEN and ASPEN (American Society for Parenteral and Enteral Nutrition) guidelines address fiber use in enteral nutrition, specific recommendations for critically ill patients are limited and context dependent.[1,26] Meta-analyses suggest that its administration is safe and may reduce mortality and gastrointestinal symptoms, improving tolerance to EN and, consequently, adequacy of nutritional intake.[27,28]

Several factors contribute to intolerance to EN, such as medications, severity of the disease and formulation composition.[29] In this context, protein quality and digestibility play a central role in gastrointestinal tolerance and in the preservation of muscle mass and anabolic response. Calcium caseinate, which was the main protein source in 50% of the formulations, may exhibit different gastric behavior compared with micellar casein.[30,31] Casein in its micellar structure tends to coagulate in the stomach due to the combined effects of gastric acidity and pepsin, forming dense curds that may slow gastric emptying and digestion.[30,31] In contrast, caseinates are present in a non-micellar form and tend to form less structured aggregates during gastric digestion, which may influence protein hydrolysis and nutrient delivery. In comparison, whey proteins are generally characterized by faster gastric emptying and more rapid postprandial amino acid availability, reflecting distinct digestive kinetics among milk proteins.[32] Nevertheless, formulas containing a protein blend (P4) may provide a more balanced amino acid profile and improved digestibility.[6,30] In vitro digestion studies have shown that EN with P4 (predominantly vegetable or dairy origin) did not form coagulum and maintain adequate viscosity and stability.[22,23] Despite these potential advantages, only 16.7% of the analyzed formulations presented this protein profile. Although several formulations met regulatory recommendations regarding the proportion of energy derived from protein,[10] these criteria refer primarily to quantitative aspects of protein content and do not address differences in protein sources and their digestive behavior.

Leucine is a key amino acid involved in the activation of the mechanistic target of rapamycin (mTOR) signaling pathway and the stimulation of muscle protein synthesis.[33] According to FAO/WHO (Food and Agriculture Organization/Word Health Organization) recommendations, the daily leucine intake should be approximately 39 mg/kg/day, corresponding to 2.73 g/day for a 70-kg adult.[34] In the formulations that provided amino acid composition data, the mean leucine content was 6.4 ± 2.4 g/L, indicating that even a daily intake of 500 mL of EN would meet or exceed the recommended amount.

Medium-chain triglycerides (MCTs) were the main lipid source in 21.5% of the enteral nutrition (EN) formulations analyzed and are characterized by rapid digestion and absorption, as they do not require emulsification by bile salts for intestinal absorption.[35] Omega-3 fatty acids, known for their anti-inflammatory properties and potential benefits for muscle health,[36] were present at an omega-6:omega-3 ratio of 4.7:1 (3.4:1–6.1:1), with 61.9% of the formulations containing fish oil. Although no specific omega-6:omega-3 ratio has been established for critically ill patients, the observed ratio was close to the DRI reference value of 5:1.[37] In addition, the combination of different lipid sources in EN provides a variety of fatty acids, phytosterols, and bioactive compounds that may contribute to inflammatory and immunological modulation as well as metabolic regulation.[38,39]

Clinical prognosis in critically ill patients may be influenced by the adequacy of nutritional support, particularly due to its potential role in modulating inflammation, oxidative stress, and muscle loss.[2,5] During the early phase of critical illness, when the progression of enteral nutrition may be gradual and caloric targets are often not fully achieved, the reduced volume of enteral nutrition delivered may limit the intake of some micronutrients.[40] In this context, the composition of enteral nutrition formulations becomes particularly relevant. In addition to components commonly associated with anti-inflammatory effects, such as fish, flaxseed, and saffron oils and prebiotic fibers, other aspects of formulation composition, including the sources of macronutrients, should also be considered.[24,38] Different protein sources, lipid profiles, and carbohydrate types may influence gastrointestinal tolerance and interact with the intestinal microbiota, potentially affecting metabolic and clinical responses in critically ill patients.[24,30]

As this study was based on nutritional information reported on product labels and provided by manufacturers, some limitations should be considered when interpreting the results. The declared composition may not fully reflect the actual nutrient content of the formulations, particularly because physicochemical characteristics and external factors during production and storage may influence nutrient stability. In addition,

information on leucine content was not available for all enteral nutrition formulations, which limited a more comprehensive evaluation of amino acid composition and its implications for protein quality. Despite these limitations, this study provides a detailed overview of the macro- and micronutrient composition of enteral nutrition formulations available for use in Brazilian ICUs, contributing to the current understanding of their nutritional characteristics.

CONCLUSION

Enteral nutrition formulations available for use in Brazil generally met the micronutrient levels established by Brazilian and European regulations, although except for vitamin D. Most formulations contained maltodextrin as the main carbohydrate source, while protein blends and lipid sources commonly associated with anti-inflammatory properties were less frequently identified. These findings provide an overview of the nutritional composition of enteral formulas available in the Brazilian market and may support clinical decision-making when selecting formulations for critically ill patients. The results should be interpreted considering the study limitations, including the use of nutritional information obtained from product labels.

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CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

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