CHAPTER
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Lipid nutritional quality of industrialized enteral formulas available in the Brazilian market

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Marciele Alves Bolognese
PhD student, Post-graduation in Food Science, State University of Maringá – UEM.
E-mail: mafb-2006@hotmail.com

Alisson de Lima Figueiredo
Master's student, Post-graduation in Analytical Chemistry, State University of Maringá – UEM.
E-mail: alissonfigueiredo99@gmail.com

Oscar de Oliveira Santos Júnior
Researcher, PhD, Graduate Program in Food Science, State University of Maringá – UEM.
E-mail: oliveirasantos.oscardeoliveira@gmail.com

Jesuí Vergílio Visentainer
Supervisor, PhD, Graduate Program in Food Science, State University of Maringá – UEM.
E-mail: jesuiv@gmail.com

ABSTRACT
The lipid nutritional quality of enteral formulas is an important factor to consider since the composition can affect the patient's lipid profile and immune response. Proper selection of the types and amounts of fatty acids present in enteral nutrition formulas play a key role in promoting health and preventing disease. Excessive consumption of saturated fatty acids and trans fatty acids may be associated with an increased risk of cardiovascular disease and an exacerbated inflammatory response. Therefore, it is essential that health professionals responsible for planning and prescribing enteral formulas consider not only the caloric needs, but also the quality of the lipids offered in the formulas.

Keywords: Enteral Nutrition, Lipids, Fatty Acids, Omega-3, Omega-6.

1 INTRODUCTION

Enteral nutrition (NE) is a specialized liquid diet, provided through a nasogastric or post-pyloric tube to individuals who cannot or cannot feed properly by the conventional way (PEROTE, VIEIRA & MEDEIROS, 2014; OLIVE TREE *et al*., 2021). Early nutritional diagnosis by a multidisciplinary nutritional therapy team can prevent some health complications, such as malnutrition, infectious processes and longer hospital stay (CONRAD, *et al*., 2018; BRAZIL, 2016).

The nutritional composition of enteral formulas may vary according to the individual needs of patients. Standard formulas are designed to meet general nutritional recommendations, containing macronutrients such as carbohydrates, proteins, and lipids. On the other hand, specialized formulas are developed to meet the specific needs of patients, and may include the absence, reduction, increase, partial or total hydrolysis of nutrients (DIAS & ALVES, 2019).

Carbohydrates are the main source of energy and usually account for about 50 to 60 percent of total calories. They can be supplied in the form of maltodextrin, starch or other simple sugars (GOMES, et al., 2020). Proteins play an essential role in tissue maintenance and recovery and generally account for about 15 to 20 percent of total calories (BAUER, *et al*., 2019). They can be supplied in the form of whey protein, casein, soy protein, among others (CAMICIA, *et al*., 2021). Lipids, in addition to acting as a source of energy, play an important role in the physiological and metabolic functions of the human

body. They typically account for about 25 to 35% of total calories (WAITZBERG, *et al*., 2001). Lipids can be supplied in the form of vegetable oils such as soybean oil or canola oil, fish oil and medium-chain triglycerides (INSTITUTE OF MEDICINE, 2005).

The lipid composition of enteral diet formulas can vary from 2 to 45% of total calories (FUENTES-ANTRÁS, *et al*., 2021). According to the *Food and Agriculture Administration and World Health Organization* (FAO/WHO), the recommended daily intake of lipids present in food is 15% to 35% of the total energy value (VET) to meet the metabolic needs of fatty acids (FA) and fat-soluble vitamins (FAO/WHO, 2010).

FAs are fundamental components of lipids and can be classified into two main categories: saturated and unsaturated, and unsaturated are divided into monounsaturated and polyunsaturated. Saturated fatty acids (SFA) have only single bonds between carbons, while unsaturated fatty acids have one or more double bonds (CALDER, 2020). The *American Heart Association* (AHA) recommends that the consumption of SFA be a maximum of 10% of the total lipid percentage for healthy individuals and not exceed 6% in people with heart disease (AHA, 2017).

Monounsaturated fatty acids (MIFA) have only one double bond, and polyunsaturated fatty acids (PUFA) have two or more and are considered essential for human health, since the body is not able to systemize them and, therefore, need to be obtained through food (KRIS-ETHERTON, *et al*., 2002). Among the most relevant PUFAs, omega-3 (n-3) and omega-6 (n-6) fatty acids stand out.

N-3s are found in cold-water fish such as salmon, sardines and tuna, as well as in foods such as flaxseed, chia and walnuts (GIOXARI, *et al*., 2018). These FAs have been linked to several health benefits, such as reduced risk of cardiovascular disease, improved brain function, decreased inflammation, and protection against certain cancers (MOZAFFARIAN, 2016). N-6 are found in vegetable oils, such as corn, soybean and sunflower oil, as well as meat and eggs (SIMOPOULOS, 2016). Importantly, excessive consumption of omega-6 fatty acids may be associated with a higher risk of chronic inflammation and diseases such as diabetes and obesity. Thus, the World Health Organization (WHO) recommends that the ratio between PUFA/SFA be at least greater than 0.45, for health maintenance and especially the prevention of heart disease (WHO, 2018). In addition, PUFAs have been associated with several other benefits, such as the prevention of depression, improved eye health, protection against cognitive decline in the elderly, among others (GIOXARI, *et al*., 2018).

How Mentioned earlier, enteral formulas are liquid preparations developed to provide essential nutrients to individuals who have specific needs due to health condition or inability to eat properly through the conventional diet. The lipid composition of these formulas may vary according to the purpose and nutritional profile of the patient.

2 RESULTS

Currently there are several enteral formulas in the national market. They are specific to meet the needs of patients, offering enteral nutrition appropriate to their clinical and nutritional status. It is important for enteral nutrition therapy professionals to know the precise composition of these formulas, especially the lipid composition.

The following table was created based on data provided by the respective laboratories. The enteral formulas are organized as follows: (1) Laboratory A, B, C, D and E, (2) Type of formulas, developed to meet special needs, such as standard and hypercaloric, hyperprotein, diabetes, renal failure, liver failure, among others, (3) Caloric density (kcal/ml), (4) Lipids in g/100 ml, (5) Total fats (saturated, monounsaturated and polyunsaturated) in g/100 ml, (6) Cholesterol in mg/100ml, (7) Relationship between PUFA and SFA, (8) Percentage of calories related to lipids considering a diet of 2000 calories and (9) Percentage of SFA on dietary lipids.

	LIPID NUTRITIONAL COMPOSITION OF INDUSTRIALIZED ENTERAL FORMULAS DISTRIBUTED IN BRAZIL (g/100 ml)									
	TOTAL FATS (g)									
LAB	**FORMULA TYPE***	**CALORIC DENSITY**	**LIPIDS (g)**	**SATURATED (g) - AGS**	**MONOUNSATURATED (g) - AGMI**	**POLY-UNSATURATED (g) - PUFA**	**CHOLESTEROL (mg)**	**AGPI/AGS**	**Lipids / liter (g/l) % of calories referring to lipids considering a diet of 2000 calories (VET)**	**% of AGS/ LIPIDS**
A	Pattern	1,09	3,4	0,7	ND	ND	0	-	15,30	20,59
A	Pattern	1	3	0,6	1	1	0	1,66	13,50	20,00
A	Pattern	1	3,5	0,5	ND	ND	ND	-	15,75	14,29
A	Pattern	1	3	0,6	ND	ND	0	-	13,50	20,00
A	Pattern	1,2	3	0,5	ND	ND	0	-	13,50	16,67
C	Pattern	1	5,4	ND	ND	ND	ND	-	24,30	-
D	Pattern	1,23	4,1	2,3	ND	ND	ND	-	18,45	56,10
E	Pattern	1	4,4	1,3	2	1,1	ND	0,84	19,80	29,55
E	Pattern	1	4,4	1,3	2	1,1	ND	0,84	19,80	29,55
E	Pattern	1	3,4	0,4	1,9	9,1	ND	22,75	15,30	11,76
C	Pattern	1	3,9	0,4	2,3	1,2	ND	3,00	17,55	10,26
C	Pattern	1	3,9	0,4	2,3	1,2	ND	3,00	17,55	10,26
B	Pattern	1,06	2,85	0,07	0,42	0,2	ND	2,86	12,82	2,46
B	Pattern	1,06	3,47	0,24	0,52	0,17	ND	0,71	15,61	6,92
B	Pattern	1,06	3,6	0,25	0,53	0,18	ND	0,86	16,20	6,94
E	Pattern	1	3,4	0,5	ND	ND	ND	-	15,30	14,71
E	Pattern	1	3,4	1,4	ND	ND	ND	-	15,30	41,18
C	Pattern	1,01	3,4	0,74	1,49	1,17	ND	1,58	15,30	21,76
C	Pattern	1,04	3,62	0,79	1,51	1,32	ND	1,67	16,29	21,82
D	Pattern	1	3,8	1,12	1,45	0,93	2,8	0,83	17,10	29,47
B	Pattern	1	3,72	0,17	0,29	0,64	ND	3,76	16,74	4,57
D	Pattern	1	4	1,05	1,97	0,64	3,36	0,61	18,00	26,25
C	Pattern	1	4,4	0,4	2,7	1,3	ND	3,25	19,90	9,09

C	Pattern	1	4,4	0,4	2,7	1,3	ND	3,25	19,90	9,09
C	Pattern	1	4,2	0,5	2,4	1,3	ND	2,60	18,90	11,90
D	Pattern	1	5	ND	ND	ND	1,26	-	22,50	-
D	Pattern	1,2	4,1	ND	ND	ND	0,4	-	18,45	-
D	Pattern	1,2	4,1	ND	ND	ND	0,4	-	18,45	-
C	Hypercaloric and hyperproteic	1,6	5,6	1	1,6	3	ND	3,00	25,20	17,86
C	Hypercaloric and hyperproteic	1,5	5,3	0,6	3,2	1,5	ND	2,50	23,85	11,32
D	Hypercaloric and hyperproteic	2,01	6,3	0	ND	ND	ND	-	28,35	-
D	Hypercaloric and hyperproteic	1,52	6	2	ND	ND	ND	-	27,00	33,33
E	Hypercaloric and hyperproteic	1,5	5,8	3,7	0,5	1,5	ND	0,40	26,10	63,79
E	Hypercaloric and hyperproteic	1,3	7,2	2,8	3,3	1,1	ND	0,39	32,40	38,89
E	Hypercaloric and hyperproteic	1,5	6,7	0,6	4,9	1,2	ND	2,00	30,15	8,96
C	Hypercaloric and hyperproteic	1,5	5,8	0,6	3,4	1,8	ND	3,00	26,10	10,34
B	Hypercaloric and hyperproteic	1,5	5	0,21	0,45	0,87	ND	4,14	22,50	4,20
B	Hypercaloric and hyperproteic	1,5	4,91	0,34	0,3	0,34	ND	1,00	22,09	6,92
C	Hypercaloric and hyperproteic	1,5	5,8	0,6	3,4	1,8	ND	3,00	26,10	10,34
C	Hypercaloric and hyperproteic	1,5	3,33	0,51	1,92	0,89	ND	1,74	14,98	15,32
A	Hypercaloric and hyperproteic	1,33	3,7	0,9	ND	ND	0	-	16,65	24,32
A	Hypercaloric	1,3	3	0,6	1	ND	0	-	15,30	20,00
D	Hypercaloric	1,5	6,7	2,8	ND	ND	ND	-	30,15	41,79
E	Hypercaloric	1,5	5,8	1,3	2,8	1,7	ND	1,31	26,10	22,41
E	Hypercaloric	1,5	6,7	2	3	1,7	ND	0,85	30,15	29,85
E	Hypercaloric	1,5	6,7	0,7	3,2	1,7	ND	2,43	30,15	10,45

E	Hypercaloric	1,5	6,7	0,7	3,2	1,7	ND	2,43	30,15	10,45
E	Hypercaloric	1,5	5,8	1,3	2,8	1,7	ND	1,31	26,10	22,41
E	Hypercaloric	1,5	5,8	1,3	2,8	1,7	ND	1,31	26,10	22,41
C	Hypercaloric	1,5	5,8	0,6	3,4	1,8	ND	3,00	26,10	10,34
E	Hypercaloric	1,5	5,8	0,9	ND	ND	ND	-	26,10	15,52
C	Hypercaloric	1,5	6,7	0,7	4	2	ND	2,86	30,15	10,45
C	Hypercaloric	1,5	6,8	0,7	4,1	2	ND	2,86	30,60	10,29
D	Hypercaloric	1,52	4,6	ND	ND	ND	1,68	-	20,70	-
D	Hypercaloric	1,5	6,5	ND	ND	ND	0,4	-	29,25	-
B	hyperproteic	1,23	2,6	0,6	0,7	1,3	3,5	2,17	11,70	23,08
E	hyperproteic	1	3,3	2	0,2	1,1	ND	0,55	14,85	60,61
C	hyperproteic	1	3,33	1,15	1,43	0,75	ND	0,65	14,98	34,53
D	hyperproteic	1	4,7	2,7	ND	ND	6,7	-	21,15	57,45
B	hyperproteic	1	2,6	1,1	0,31	1,43	ND	1,30	11,70	42,31
B	hyperproteic	1,06	3,59	0,25	0,53	0,18	ND	0,72	16,15	6,96
C	hyperproteic	1,25	4,9	0,5	2,9	1,5	ND	3,00	22,05	10,20
B	hyperproteic	1,2	3,93	0,27	0,52	0,17	ND	0,63	17,68	6,87
B	hyperproteic	1,2	3,93	0,27	0,52	0,17	ND	0,63	17,68	6,87
C	hyperproteic	0,99	3,22	ND	ND	ND	ND	-	14,49	-
C	hyperproteic	1	2,1	0,3	1,2	0,6	ND	2,00	9,45	14,29
C	hyperproteic	1,25	3,5	0,4	2,1	1	ND	2,50	15,75	11,43
D	hyperproteic	1,2	4,1	ND	ND	ND	0,4	-	18,45	-
A	Diabetes	1	3,2	0,7	ND	ND	0	-	14,40	21,88
A	Diabetes	1,2	4	1	ND	ND	0	-	18,00	25,00
B	Diabetes	0,93	3,4	0,3	2,4	0,4	0	1,33	15,30	8,82
B	Diabetes	1	5,44	0,21	1,84	0,4	ND	1,90	24,52	3,86
E	Diabetes	0,9	3,2	0,5	ND	ND	ND	-	14,40	15,63
C	Diabetes	1	4,2	0,5	2,9	0,8	ND	1,60	18,90	11,90
D	Diabetes	1	4,4	ND	ND	ND	ND	-	19,80	-
C	Diabetes	1	5,4	0,46	2,2	1,11	ND	2,41	24,30	8,52
D	Diabetes	1	4,9	ND	ND	ND	0,84	-	22,05	-
D	Diabetes	1,06	4,7	ND	ND	ND	1,26	-	21,15	-
A	Nephropathy	2	6,3	1,3	ND	ND	0	-	28,35	20,63
A	Nephropathy	2	7	1,5	ND	ND	0	-	31,50	21,43
B	Nephropathy	2	9,56	0,33	2,69	0,79	ND	2,39	43,02	3,45
B	Nephropathy	2	9,56	0,38	2,68	0,85	ND	2,24	43,02	3,97
C	Nephropathy	1,3	3	ND	ND	ND	ND	-	15,30	-
D	Nephropathy	2	2,41	ND	ND	ND	0,84	-	10,84	-

A	Liver disease	1,6	4,4	1,1	ND	ND	0	-	19,80	25,00
A	Liver disease	1,4	4	1	ND	ND	0	-	18,00	25,00
C	Liver disease	1,25	3	ND	ND	ND	ND	-	15,30	-
C	Immuno modulator formulas	1	3,24	ND	ND	ND	ND	-	14,58	-
D	Immuno modulator formulas	1	2,8	ND	ND	ND	0,56	-	12,60	-
D	Immuno modulator formulas	1	2,8	ND	ND	ND	0,56	-	12,60	-
D	Immuno modulator formulas	1,3	2,8	ND	ND	ND	0,56	-	12,60	-
B	Pneumopata	1,5	9,2	0,28	2,13	1,28	ND	4,57	41,40	3,04
B	Pneumopata	1,5	9,37	3,38	2,77	3,26	ND	0,96	42,16	36,07
C	Pneumopata	1,6	9,84	ND	ND	ND	1,9	-	44,28	-
D	Pneumopata	1,5	6,8	ND	ND	ND	0,8	-	30,60	-
D	Hydrolysed formulas	1	3,9	2,56	0,26	0,45	2	0,17	17,55	65,64
B	Hydrolysed formulas	1	1,53	0,09	0,01	0,11	ND	1,22	6,97	5,88
E	Hydrolysed formulas	1	2,4	1,5	ND	0,7	ND	0,47	10,80	62,50
B	Hydrolysed formulas	1,3	3,72	0,4	0,25	0,2	ND	0,50	16,74	10,75
C	Hydrolysed formulas	1,03	1,59	ND	ND	ND	ND	-	7,15	-
D	Hydrolysed formulas	1	3,9	2,8	0,3	0,54	0,48	0,19	17,55	71,79
D	Hydrolysed formulas	1	3,9	2,23	0,52	0,54	2	0,24	17,55	57,18
D	Hydrolysed formulas	0,8	2,4	ND	ND	ND	ND	-	16,74	-
C	Hydrolysed formulas	0,71	3,5	1,1	1,7	0,7	ND	0,64	15,75	31,43
D	Hydrolysed formulas	1	0,64	ND	ND	ND	ND	-	2,88	-
D	Supplements	0,55	0,5	0,5	ND	ND	2,5	-	2,25	100,00
D	Supplements	0,55	0,5	0,5	ND	ND	2,5	-	2,25	100,00
D	Supplements	0,55	0,5	0,5	ND	ND	2,5	-	2,25	100,00

D	Supplements	0,55	0,5	0,5	ND	ND	2,5	-	2,25	100,00
C	Supplements	1,05	0,6	ND	ND	ND	ND	-	2,70	-
D	Supplements	1,24	3,26	ND	ND	ND	ND	-	14,67	-

Note: ND: nutritional information not available. (-) it was not possible to determine PUFA/AGS and %AGS/IPL due to lack of information on the labels.
*Some products may not be on the table or have been excluded from the market due to publication time.
Note. Table adapted from Chemin et al., (2016).

3 DISCUSSION

The following were analyzed: the labeling information of 111 enteral formulas available in the Brazilian market. Some laboratories have not reported the amount of fats in enteral formulas. The lack of standardization in the nutritional information present on the packaging is a problem that can hinder the comparison between the products available in the market and also, the appropriate choice for patients.

Analyzing the amount of total lipids offered by each formula presented it is possible to observe that 25 formulations are below the minimum index of total lipids (15%) established by the *Food and Agriculture Administration and World Health Organization,* according to the VET, with emphasis on supplements, totaling 5 formulas in the different laboratories, followed by immunomodulatory formulations with 4. In addition, 5 formulations are above the maximum recommended index (35%), being 2 formulas referring to patients with nephropathy and 3 to lung disease (FAO/WHO, 2010).

The standard formulas, which resemble a conventional diet, showed an amount of total lipids within the daily recommendations, however, with values very close to the minimum allowed. On the other hand, almost all the specific formulas for pneumopathic patients presented values higher than those recommended, that is, greater than 35% of the VET. Many formulas have shown values well below the recommendations, especially in the supplement line. In addition, it is possible to observe that there is no standardization in the amount of lipids according to the clinical indication, with a discrepancy especially in the formulas intended for patients with kidney disease.

Another point to highlight is the amount of SFA in the observed formulas. There is no standardization of this class of compounds in the different types of formulations, and some of these do not present the amount of AGMI and PUFAs on their labels, especially supplements, which have 100% of the total lipid content as SFA. In addition, in the enteral diets studied there is no concern with the amount of SFA, since 67 formulations (60.4%) presented a content above 10% of the total lipid value, not adapting to health recommendations. In addition to what was reported, 103 observed formulations (92.8%) have an SFA content above 6%, not being recommended for patients with heart disease.

In terms of the PUFA/SFA ratio, among the formulas analyzed, it was not possible to verify this relationship in 51 samples due to lack of information on the label. Of the formulas analyzed, 55

are above 0.45 and only 5 are below. It is worth mentioning that the PUFA/SFA ratio is used as an indicator to evaluate the quality of the formulas in terms of lipid profile. A ratio above 0.45 is considered favorable for health, since the intake of PUFA in greater quantities in relation to SFA is associated with cardiovascular health benefits.

Still in this context, it is essential to maintain the listed formulations that are in disagreement with the required daily lipid values, either for more or for less, since patients cannot feed conventionally and depend on enteral diets. In the medium and long term the intake of these diets in disagreement can lead patients to cases of nutritional deficiency or to heart and coronary heart disease due to the excess of this macronutrient.

4 FINAL CONSIDERATIONS

The scarcity of studies and the lack of consensus on adequate lipid levels in enteral nutrition formulas are important issues to consider. The literature presents a variety of recommendations and guidelines related to the lipid composition of enteral formulas, which may lead to different approaches in clinical practice.

It is essential to mention that the individualization of enteral formulas, taking into account the specific nutritional needs of each pathology, is a fundamental principle. In addition, factors such as clinical condition, gastrointestinal tolerance, patient lipid profile, and therapeutic goals should be considered in the selection and adjustment of the lipid composition of formulas.

Although the main health guidelines and organizations offer general recommendations, it is important to emphasize that each clinical case should be evaluated individually, considering medical guidance and specialized nutritional. Collaboration between health professionals, researchers, and regulatory bodies is needed to provide more robust evidence and establish clearer, more consensual standards for lipid composition of enteral formulas.

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