

Meat-based enteral nutrition

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Abstract. Enteral nutrition is widely used in hospitals as a means of nutritional support and therapy for different diseases. Enteral nutrition must fulfil the energy needs of the body, be balanced by the nutrient composition and meet patient's nutritional needs. Meat is a source of full-value animal protein, vitamins and minerals. On the basis of this research, recipes and technology for a meat-based enteral nutrition product were developed. The product is a ready-to-eat sterilised mixture in the form of a liquid homogeneous mass, which is of full value in terms of composition and enriched with vitamins and minerals, consists of particles with a size of not more than 0.3 mm and has the modified fat composition and rheological characteristics that are necessary for passage through enteral feeding tubes. The study presents experimental data on the content of the main macro- and micro-nutrients in the developed product. The new product is characterised by a balanced fatty acid composition, which plays an important role in correction of lipid metabolism disorders and protein-energy deficiency, and it is capable of satisfying patients' daily requirements for vitamins and the main macro- and microelements when consuming 1500-2000 ml. Meat-based enteral nutrition can be used in diets as a standard mixture for effective correction of the energy and anabolic requirements of the body and support of the nutritional status of patients, including those with operated stomach syndrome.

1. Introduction

Enteral nutrition is a kind of nutritional therapy whereby nutrients are introduced perorally or through a gastric tube. The use of this nutrition is most topical for surgical and gastroenterological patients and for any disease when the nutrient requirements of patients cannot be satisfied naturally. With that, the nutrition provided must fully meet the body's energy needs, have balanced nutrient composition and fulfil patients' nutritional needs [1]. Adequate protein consumption is necessary to maintain the nitrogen balance during illness. Provision of the optimal qualitative composition of protein (a ratio of essential and non-essential amino acids) in diets is achieved by including both plant and animal proteins, which increases their total biological value. Meat is a source of full-value animal protein, which contains all essential amino acids, some fat- and water-soluble vitamins and easily digestible haeme iron. In addition, inclusion of meat-containing products into a diet allows the extension and diversification of curative nutrition, when much attention is paid to food palatability in the design of diets, especially for patients with appetite disorders and loss of taste sensations with development of psychogenic anorexia.



2. Materials and Methods

An experimental meat-based enteral nutrition product enriched with vitamins and minerals and with a modified fatty acid profile was studied.

The organoleptic and physico-chemical indicators were determined by standard methods, fatty acid composition by gas chromatography, microbiological indicators by conventional methods, vitamins by high performance liquid chromatography, folic acid by competitive enzyme immunoassay using the test system RIDASCREEN®FAST Folsäure (Folic Acid) and minerals by the atomic absorption method. The component particle size was measured on histological preparations of the material using an image analysis system or ocular micrometre. Amino acid scores were calculated as the ratio of amount of amino acids in 1 g of the studied protein to amount of corresponding amino acids in 1 g of ideal protein, expressed in percentages; with that, the FAO/WHO amino acid scale was taken as a reference.

3. Results and Discussion

Researchers at the FGBNU The V.M. Gorbatov All Russia Meat Research Institute have developed recipes and technology for meat-based enteral nutrition products, which are intended for people in the post-operative period, and for conditions associated with appetite loss, mandibulofacial, craniocerebral and burn injuries, as well as chewing or swallowing impairment. The technology is adapted to the conventional conditions of the plants that produce meat-based child nutrition products. The developed product is a ready-to-eat, sterile mixture in the form of a liquid homogeneous mass, which is of full value in terms of composition, consists of particles not more than 0.3 mm in size and has a pleasant, slightly sweet taste and light brown colour. To stabilise the homogenous multicomponent mass and to prevent separation of the liquid phase during storage, we used a complex stabilising additive, which consisted of a mixture of hydrocolloids in an amount that ensured the rheological characteristics necessary for passing through enteral feeding tubes [2]. The total composition of nutrients was based on the recommendations for healthy adults. The nutrient content in a portion (240 g) of the enteral nutrition product and the percentage of the daily requirement of macro- and micro-nutrients are given in tables 1 and 2.

Table 1. The nutrient content in a portion (240 g) of the enteral nutrition product and the percentage of the daily requirement.

Indicator	Content in a portion	% of daily requirement
Energy value, kcal	254.0	10
Protein mass fraction, g	9.6±0.1	12
Fat mass fraction, g	9.6±0.2	10
Carbohydrate mass fraction, g	33.6±0.2	10

Specialised enteral nutrition products must contain the full complex of vitamins and minerals, to avoid their deficiency when this artificial support is used over a long period of time. The mineral and vitamin contents of the developed product meet patients' daily requirements for vitamins and the main macro- and microelements when consuming 1500-2000 ml of product. The composition of the vitamin-mineral premix added to the product was adjusted to take into account results of preliminary studies. These showed losses of individual components in the course of the technological process and during product storage, so the adjusted amount provided a guaranteed level of those vitamins and minerals in the finished product.

Adequate protein intake is necessary to maintain nitrogen balance during illness. Assurance of the optimal qualitative composition of protein (a ratio of essential and non-essential amino acids) in a diet is achieved by including both animal and plant proteins, which increases their total biological value. The protein component in the studied product was a mixture of animal protein (beef with a mass fraction of fatty and connective tissues of not more than 6%) and plant protein (soya), in a ratio that

ensured the product's high biological value; the minimal utility coefficient score was 0.99 unit fractions. This compares well with the utility coefficient that characterises the balance of essential amino acids relative to the physiologically necessary norm (FAO/WHO), which is 0.83 unit fractions.

Table 2. The content of selected vitamins and minerals in a portion (240 g) of the product and the percentage of daily requirement.

Mass fraction of vitamins			Mass fraction of minerals		
		% of average daily requirement			% of average daily requirement
B1, mg	0.36±0.02	24	Sodium (Na) , mg	240.0±36.0	19
B2, mg	0.38±0.03	24	Potassium (K) , mg	420.0±21.0	12
PP, mg	4.3±0.06	24	Calcium (Ca) , mg	192.0±28.8	19
B5 , mg	1.2±0.02	21	Phosphorous (P) , mg	172.8±34.4	21
B6, mg	0.4±0.01	21	Magnesium (Mg) , mg	55.2±11.0	14
B12, µg	0.48±0.01	48	Iron (Fe) , mg	3.8±0.57	26
Bc, mg	0.099 ±0.016	31	Copper (Cu), µg	360.0±72.0	36
H, µg	9.6± 0.9	19	Zinc (Zn) , mg	2.9±0.43	19
C, mg	24.0±4.0	38	Iodine (I), mg	0.030±0.004	21
A, µg	196.8±6.18	24	Manganese (Mn), mg	0.48±0.07	24
D3, µg	1.68±0.07	31	Selenium (Se), µg	13.68±2.74	19
E, mg	3.12±0.07	31	Chloride (Cl), mg	300.0±60.0	13

The fatty acid ratio plays an important role in correction of lipid metabolism disorders and protein-energy deficiency. Among the anti-alimentary factors of meat products is quite a high fat content with a prevalence of saturated fatty acids and cholesterol, which can lead to increasing blood lipid levels. Modification of the fat composition of specialised products *via* enrichment with monounsaturated and polyunsaturated fatty acids plays an important role in correcting lipid metabolism disorders. The fat component in the studied product is a combination of fat from the meat raw material, which contains mainly saturated fatty acids, and a mixture of rapeseed and soya oils, which provides a high level of monounsaturated and polyunsaturated fatty acids. Monounsaturated acids decrease the amount of harmful low density lipoproteins without injuring the protective high density lipoproteins. The oil ratio was selected in such a way as to fulfil the patient's need for essential $\omega 6$ and $\omega 3$ polyunsaturated fatty acids in a ratio not higher than 5:1. Table 3 presents the fatty acid composition of the meat-based enteral nutrition product. The fat component of this product contains relatively low levels of saturated fatty acids, has significantly higher content of monounsaturated fatty acids and a low ratio of omega-6 to omega-3 fatty acids (up to 4:1).

Table 3. Fatty acid composition of the enteral nutrition product.

Fatty acid	Fatty acid content, %
Lauric 12:0	0.03
Myristic 14:0	0.53
Isopentadecanoic 15:0i	0.04
Anteisopentadecanoic 15:0ai	0.04
Pentadecanoic 15:0	0.11
Palmitic acid 16:0	9.34
Margaric 17:0	0.25
Stearic 18:0	4.69
Arachidic 20:0	0.75
Behenic 22:0	0.34
Total saturated fatty acids	16.12
Myristoleic 14:1	0.17
Pentadecenic 15:1	0.05
Hexadecenic 16:1	0.08
Palmitoleic acid 16:1 9-cis	1.11
Erucic acid 22:1	0.12
Heptadecenic 17:1	0.28
Oleic 18:1	49.36
Elaidic 18:1	0.25
Gondoic 20:1	0.88
Vaccenic 18:1 11-trans	2.26
Octadecenoic 18:1 11-cis	0.01
Iso-octadecenoic 18:1i	0.14
Total monounsaturated fatty acids	54.71
Linoleic 18:2	23.47
α -Linolenic acid 18:3 ω -3	5.54
Iso-Linoleic 18:2i	0.16
Total polyunsaturated fatty acids	29.17

To manufacture the product, meat raw material (beef) was obtained from healthy animals raised without the use of growth promoters, hormones, feed antibiotics or other kinds of unconventional feed materials. This ensured the specified safety requirements of finished product were met. Table 4 presents the indicators that characterise finished product safety.

The product met the requirements of commercial sterility for canned foods of group A in terms of the sanitary and microbiological indicators.

The clinical efficiency and product tolerability were assessed in the clinic at FGBUN's FRC of Nutrition and Biotechnology in patients with operated stomach syndrome [3]. The use of our meat-based enteral nutrition product in the diet of patients with operated stomach syndrome did not cause the occurrence of any adverse effects and was not accompanied by an increase in the intensity of

existing complaints. Importantly, consumption of this product was characterised by decreases in the manifestation of heaviness in the epigastrium and decreased nausea, plus improvement of stool consistency in this population of patients. Moreover, it also facilitated an increase in all body composition indicators, and positively affected dynamics of laboratory indicators of protein metabolism among the patients.

Table 4. Safety indicators of the enteral nutrition product.

Indicator	Levels detected in the prepared enteral nutrition product	Maximum allowable levels
<i>Mass concentration of toxic elements, mg/kg:</i>		
Lead	0.026±10%	0.5
Arsenic	< 0.01	0.1
Cadmium	< 0.01	0.05
Mercury	< 0.002	0.03
<i>Antibiotics, mg/kg:</i>		
Levomycetin	not detected (detection limit 0.00008 mg/kg)	not allowed (<0.0003)
Tetracycline group	not detected (detection limit 0.01 mg/kg)	not allowed (<0.01)
Streptomycin	not detected (detection limit 0.1 mg/kg)	not allowed
Bacitracin	not detected (detection limit 0.004 mg/kg)	not allowed (<0.02)
<i>Pesticides, mg/kg:</i>		
Hexachlorocyclohexane (α -, β -, γ -isomers)	not detected	0.1
DDT and its metabolites	not detected	0.1
<i>Radionuclides, specific activity, Bq /kg:</i>		
Cesium-137	0±13	not more than 200
Strontium-90	0±18	-

4. Conclusion

As a result of this study, the recipe and technology for a meat-based enteral nutrition product have been developed. The product has balanced amino acid and fatty acid compositions, and is enriched with vitamins and minerals. Consumption of the product ensured effective correction of the energetic requirements among patients with nutritional status disorder caused by operated stomach syndrome.

References

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